Pavement Condition and Performance Observations

Brampton Test Road

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ABSTRACT

The Brampton Test Road constructed in 1965, consisted of 36 sections to test the effects of different base types and thicknesses. Previous reports on the performance of the test sections developed base material equivalencies and the relations of thickness with traffic and performance which were used to create methods of pavement thickness design. This report concentrates on the reporting of pavement distresses using a pavement condition rating scheme which was developed to determine rehabilitation needs and priorities. The pavement condition at any time is reported by a Distress Index, DI, which contains a principal element, Riding Comfort Rating (RCR), and a Distress Manifestations (DM) element.

Pavement Condition is reported for each section at the time just prior to its' resurfacing, i.e. the DI, the RCR, the DM, together with summary assessments of the type, extent and severity of surface defects, deformation, and cracking. The progress of each type of crack is traced on plots of DM vs numbers of standard axle load repetitions, for each of the test sections.

It was observed that rutting had a very significant effect on condition, and that alligatoring of areas in or near the wheel tracks or pavement edges triggered maintenance actions. Transverse cracking in cement treated base sections was observed to lead to early deterioration at these cracks. Reference is made to rut depth and fatigue prediction models developed from the Brampton Test Road data.

Principal failure mode observations were made for each base type.

Gravel equivalency values for each base material used i.e. asphalt concrete, crushed rock, bituminous stabilized, cement treated sand, and the sand subbase, were derived from the terminal data, and compared with other gravel equivalencies reported earlier from deflection measurements and elastic layer analyses.

Finally, the performance and 15 year life of the two standard design sections included in the experiment, verifies these standard designs, and increases confidence in future applications.

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Pavement Condition and Performance Observations Brampton Test Road

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INTRODUCTION

In 1965, thirty-six short experimental test sections of flexible pavement were constructed on Highway 10, north of Brampton. The objectives of the experiment were:

- to extend the results of the AASHO Road Test to the materials and environment of Ontario;
- to evaluate the standard pavement designs; and
- to observe the performance of five types of base material and develop equivalency values for these materials.

The test sections were located on the two northbound lanes (new widening) of a four-lane undivided highway. Each section was 61 m (200 ft.) long, with 15 m (50 ft.) transitions between sections.

The main variable in the experiment was base type; materials used were asphalt concrete, crushed gravel, crushed rock, bituminous stabilized sand, and cement treated sand. These five base materials were laid in thicknesses of 50, 100, 150, or 200 mm (2, 4, 6 or 8 inches), as was considered practical for the particular section.

The asphalt concrete surfacing was 90 mm (3 1/2 inches) thick in all sections except in four sections where an additional 50 mm (2 inch) layer was placed. The sand subbase under the main experimental sections was 150 mm (6 inches) thick; other experimental sections either had no sand subbase or had 200 mm (18 inches) of sand subbase.

To ensure a uniform subgrade, existing ground was replaced to a depth of one meter with selected light clay borrow material. Figure 1 is a layout of the test sections. Construction of the experiments and in-situ materials data were reported by Schonfeld (1). Extensive testing of the materials used in this experiment was undertaken by the Asphalt Institute. Results of these tests were reported by Kallas (2,3).

Four, and five year performance results of the experiment were reported by Phang (4,5). Examination of these results by elastic layer analysis techniques were reported by Haas, Kamel and Morris, (6). Jung, Kher and Phang used an elastic layer approach (7) to examine the Brampton Test Road data and to develop "A Subsystem for Flexible Pavement Performance Prediction" (8). This subsystem forms the heart of the computerized OPAC Flexible Pavement Design System (9), which is currently in use in Ontario.

The experiment has certainly satisfied all of its' objectives. Nevertheless a report documenting the long term observations of performance of the test sections would reassure pavement designers and provide data from which further insights might be gained. The experiment is now 15 years old, and four of the sections have survived free of any patching or resurfacing. This report presents observations of the appearances of various distress manifestations, and serviceability evaluations, and discusses the effects of base type and thicknesses on performance, the development of distresses, and the structural equivalence of various base materials.

REPORTING PAVEMENT CONDITION

In this report the measurement of present condition is called Distress Index (DI), and the effects of surface distresses, deformation and cracking are represented by Distress Manifestations (DM). Details of the development of this scheme of pavement condition reporting are given in Ref. 11. DI is calculated as follows:

$$DI = 100(0.1 \times RCR)^{1/2} \times \frac{320 - DM}{320} \qquad (1)$$

where the Ride Comfort Rating (RCR) equals PPR in equation (2),

$$PPR = 12.73 - 4.53 \log 'q' \qquad (2)$$

Measurements for surface roughness 'q' were made with a TRRL Profilometer, and the PPR relationship was established through correlation with panel ratings and road user opinion (4,10).

Distress Manifestations (DM) is the sum of defects obtained by summing the products of the sum of the density and severity weights multiplied by the weight for the distress type.

The weights for severity and density are shown in Table 1, while the weights for different distress types are shown in Table 2. The complete system of distress manifestation recognition and description is contained in the "Manual for Condition Rating of Flexible Pavements - Distress Manifestations" and the companion manual for rigid pavements (12,13).

Figure 2.1 shows a typical completed worksheet for reporting pavement condition while Figure 2.2 is on an example calculation for DM and DI. The maps of cracking of the various sections at the Brampton Test Road made over the years were converted to this scheme of pavement condition reporting in an attempt to determine how the progression of distresses affect pavement performance.

PAVEMENT CONDITION RESULTS PRIOR TO RESURFACING

The complete set of pavement condition results is too large to reproduce in this report. The most interesting part of the report for each section is the condition of the pavement just prior to major maintenance work. This is work such as resurfacing more than 50% of the section. This information is presented in Table 3, for each test section.

It should be understood that the maintenance of the whole of the Brampton Test Road was carried out by normal District maintenance forces and by contract maintenance. Decisions on what needed to be done in the way of maintenance and when it needed to be carried out, were strictly determined by District maintenance staff. However these decisions were discussed with the research staff monitoring the project, so that measurements and observations could be properly scheduled.

Generally, District maintenance was able to resurface in short enough lengths so as to not affect the observation of adjacent sections. However in many cases maintenance was triggered by failures in the transitions between sections, and these were so short that maintenance overlays generally extended into the test sections themselves. The usual thickness of maintenance overlays was 40 mm. As well, occassions arose when adjacent sections on either side needed to be overlaid, the overlay was sometimes placed right over a section which did not at that time require an overlay.

Examination of DI values in Table 3, for sections just prior to resurfacing shows no distinct patterns for timing of resurfacing. There is a cluster of values around 50, there is also a cluster between DI of 61 and 64; a section was overlaid at a DI of 39, while two sections were overlaid at a DI of 70. The section resurfaced at DI 70 still had fair riding quality with moderate rutting throughout; it was resurfaced at the same time as an adjacent section which had a DI of 49, moderate alligatoring at the pavement edge throughout the section, moderate rutting throughout, and intermittent moderate midlane cracks. The section resurfaced at a DI of 39 had been patched over 30% of the section, two years previously. Delay or acceleration of resurafacing depended in part on the urgency of the work needed and on the convenience of combining the repair work with larger nearby contract work.

PROGRESS OF DISTRESSES

The Distress Manifestations, DM, assigned to a pavement at any time is the summation of the weighted values for condition (severity and extent) of each type and class of pavement distress present. If the component weighted values for each type of distress is examined over a period of time, one can trace the progression of that specific distress and perhaps determine whether certain types of distress lead to rapid failure, and as well, perhaps note those distresses which are not as critical. The weightings for each distress type and class derived through iterative correlation with the performance of many thousands of kilometers of highway, do in fact indicate a relative deterioration gradient applicable to the specific distress. These distress type weightings are of course always open to review.

Figure 3 shows for each test section, plots of the component parts of DM against numbers of standard '9' tonne (18,000 lbs.) axle load repetitions. Each plot illustrates the progression of the distress types present over the passage of time and traffic.

Some general observations about these plots are:

1) Rut formation in the wheel tracks is the first distress type which generally appears. Rutting has a very significant effect on performance, with weighted values which in most cases over this test road, amount to over 50% of the total weighted distress DM for any section.

2) Longitudinal cracking in the wheel tracks appears to be the next most significant distress.

3) Transverse cracking is particularly significant with cement treated bases, but also contributes markedly to deterioration in sections with crushed rock bases.

4) Pavement edge cracking was significant only with the thinnest of the full depth asphalt concrete sections.

5) Alligator cracking in or near the wheel tracks generally precedes resurfacing.

The first two general observations tend to support the findings of the AASHO Road Test concerning the contributions of rutting and cracking to loss in serviceability. They also support the attention given in recent years to failure mechanisms of rutting and fatigue cracking.

Rut depth measurements taken at the Brampton Test Road were used together with data from the AASHO Road and the San Diego Road Tests, to develop a rut depth prediction model for use as a design check in the OPAC Design System (9). The model, which was developed by Meyer, Cheetham, and Haas, (14) through a joint Transportation Research project, is shown in Appendix A, for ease of reference. Table A1 in the Appendix gives details of rut depth measurements.

Fatigue cracking, which manifests itself principally as longitudinal cracking in the wheel tracks, may also first appear as short transverse cracks within the wheel track which progressively become more closely spaced before finally progressing into areas of alligatoring. This latter behaviour was observed in the sections with crushed rock bases. More generally the longitudinal cracking in the wheel tracks first appears as single cracks, becomes parallel multiple cracks, then present an alligatored appearance. This behaviour was observed in all base types except crushed rock.

In the same joint Transportation Research project mentioned above, Meyer, Cheetham and Haas developed a regression equation to calculate the value for radial tensile strain which is used to predict the load repetitions to fatigue failure of the asphalt. The equation was tested against the Brampton data, but did not appear to convincingly represent that data (14). Nevertheless the model is used in OPAC (9).

DISCUSSION OF RESULTS

More specific comments on the progress of distresses follow.

Asphalt Concrete Bases

1) Rutting in full depth asphalt sections is marginally deeper in the thinner sections than in the thicker sections.

2) The 3.5-2-0 design, Section 1, failed at the pavement edge due to snow melt getting under the pavement edge through the granular shoulder, in the late winter/early spring period and softening up the clay subgrade. The adjacent 3.5-4-0, design section, Section 2, was resurfaced at the same time as Section 1, although only a short adjacent part of the pavement edge was damaged.

3) Transverse cracking did not appear until after 10 years of service.

4) In the deep strength asphalt sections, the appearance of longitudinal cracking in the wheel tracks was earliest for the thin section (No. 6), and latest for the thick section (No. 4). This crack type progressed rapidly to alligatoring in the thin section (No. 6), but remained as a single crack in all the other sections.

5) Alligatored pavement edge cracks also created problems in the thinnest deep strength section (No. 6).

Crushed Rock Bases

1) Rutting in the crushed rock base sections are remarkably similar to rutting in other types of base materials.

2) The dominant failure mode with crushed rock bases is from alligatoring at transverse cracks which initially appear only in the wheel track area. These part transverse cracks become more and more closely spaced, longitudinal wheel track cracks appear in the thinner base sections, 13 and 12, then alligatoring forms in the wheel tracks. In the thicker sections, alligatoring appears around transverse cracks (Sections 9, 10, 14).

3) An increase in subbase thickness from 150 to 450 mm (6 to 18 inches) markedly changes the behaviour of the sections. For example, although the equivalent thickness of Section 15 (3.5-2-18 design) of 530 mm is only 50 mm more than the equivalent thickness of Section 14 (3.5-8-6 design), the appearance and progression of transverse cracks is much later and slower in Section 15. This is confirmed by the behaviour of other crushed rock base sections with the thick 450 mm (18 inch) subbases, Sections 11, 36.

4) The standard design, section 36, (5.5-6-18 design) has not been resurfaced after 15 years of service, although transverse cracks have been present for a few years.

Crushed Gravel Bases

1) Section 23 (3.5-2-6 design) failed very early in the experiment and no records are available to describe the failure mode.

2) Rut depths in the crushed gravel base sections are in general marginally greater than in crushed rock base sections; not an unexpected result due to the more rounded particle shape of gravel aggregate.

3) Failure in the gravel base sections was principally due to alligatoring in the wheel tracks. Here single longitudinal wheel track cracks became parallel multiple longitudinal cracks, then short transverse cracks appeared to create the alligator pattern. In the thinner Section 19, (3.5-4-6 design), the alligator cracking was accompanied by a significant increase in rut depth.

   Even an increase in asphalt thickness over a thin crushed gravel base did not prevent alligatoring in the wheel tracks (Section 18, 5.5-2-6 design)

4) The standard design, Section 35 (5.5-6-18 design) has not been resurfaced after 15 years of service, even though single longitudinal wheel track cracks appeared after five years.

Bituminous Stabilized Bases

1) Rutting in the section with no subbase, Section 28 (3.5-4-0 design), was substantially greater than in any other section. Rutting in sections with subbase was similar to sections with other base materials.

2) The failure mode of the two thinnest sections, 28 and 25, (3.5-4-0, and 3.5-4-6 designs) was alligatoring in the wheel tracks, in similar fashion as with crushed gravel bases.

3) The failure mode of Section 29 (3.5-6-6 design) was alligatoring around transverse cracks. Duplicate Section 26 was resurfaced early, at the same time as the adjacent Section 25 was resurfaced, but alligatoring at transverse cracks was present even then. When Section 27 (3.5-8-6 design) was resurfaced, the full transverse cracks had not yet progressed to alligatoring.

Cement Treated Bases

1) Rutting is marginally less with cement treated bases than with all other base types.

2) The dominant failure mode was alligatoring at the junctions of transverse and longitudinal cracks in or near the wheel tracks. Transverse reflection cracks appeared immediately after construction, being more closely spaced for the

thicker section, Section 34 (3.5-8-6 design). Longitudinal cracks in or near wheel tracks next appeared, earlier in Section 34 than in the other sections.

Deterioration or softening of the cement treated base material caused by the intrusion of deicing salt solution and freeze thaw cycles, accelerated the progression of the transverse cracks to alligatoring particularly at junctions with longitudinal cracks, i.e. at corners of blocks.

3) The alligatoring in the wheel tracks, which was the failure mode for the section with no subbase, Section 32 (3.5-4-0 design), was accompanied by significant rut depth formation.

EFFECT OF DM ON DI $\left[DI = (0.1 \times RCR)^{1/2} \times \frac{320-DM}{DM} \right]$

An examination of the values of DM shown in Table 3 as the distress condition prior to resurfacing indicates a maximum DM of 42. The DM of asphalt concrete base sections are a maximum of 28, with 5 of the 8 sections being below 21. The DM of 3 out of 4 of the cement treated base sections is in the 34-36 range.

The effect of DM on DI is illustrated by the following numbers:

DM	Effect on DI
20	6%
40	12%
60	19%
80	25%
100	32%

Thus for the largest value of DM found at the Brampton Test Road, 42, the effect on DI is only 13%. Examination of other provincial pavement condition data shows DM values of less than 100 in the majority of cases, i.e. in general, the effect on DI does not exceed 30%.

Since DI is a function of roughness as well as distress, it must be concluded firstly that roughness is much more important in measurement of pavement serviceability than distress, and secondly that distresses which affect roughness are much more significant than distresses which do not.

Additional evidence to support the second conclusion are the high weighting values determined for surface distortion, rutting and alligatoring longitudinally in wheel tracks and at transverse cracks. These weightings were determined after examination of a large number of pavement condition correlations with ratings.

GRAVEL EQUIVALENCIES

The OPAC Design System for evaluating design alternatives to determine the most economical thickness design (9), utilizes structural equivalencies of various materials in terms of gravel base to simplify the design process. The equation used is:

$$H_e = ah_1 + bh_2 + ch_3 \qquad (3)$$

where H_e is the equivalent thickness of gravel base,
a = 2, for asphalt concrete surface thickness, h_1,
b = 1, for granular bases of thickness, h_2, and
c = 2/3 for granular subbases of thickness, h_3.

Previous analyses of the Brampton Test Road data had produced gravel equivalencies for the various base materials, after equating structural behaviour of the different base materials i.e. equivalencies were based on equal pavement deflection under transient load (4,6). It is now possible to use the long term performance data to produce a set of gravel equivalencies which is not based on transient load deflection.

Table 4 shows the test sections arranged in ascending order of age at which resurfacing took place. In this table the last two columns are the equivalent gravel thicknesses, H_e, calculated for each section using the equivalencies listed in Notes 1 and 2 respectively. The gravel equivalents in the first of these two columns represent the current practice, as outlined in Equation (3) above and in Note 1. The gravel equivalent in the last column are calculated from the equivalencies listed in Note 2. These latter equivalencies were selected for reasons given later.

Examination of Table 4 shows that, in general, the older pavement sections have greater equivalent thicknesses of gravel, H_e. Figure 4 shows plots of equivalent gravel, H_e, versus numbers of standard axle load repetitions before resurfacing, N. The equivalent thicknesses for the crushed gravel and crushed rock sections are the same in almost all test sections, in both of the two last columns of Table 4, so these plotted points do not change location on the graph of Figure 4. However plots for other base types equivalent thicknesses would change location depending on whether Note 1 or Note 2 gravel equivalencies were used in the calculations. The points plotted on Figure 4 for other base types are for the Note 2 equivalencies, and these equivalencies were selected so that the plotted points fell as closely as possible to the points for crushed gravel and crushed rock. By this method of selecting base equivalencies it was found possible to obtain a fair correlation of equivalent thickness, H_e, with axle load repetitions, N. The relationship

$$H_e = -112.82 + 10.07 \ln N \qquad (4)$$

has a regression correlation coefficient of $r^2=0.85$ if the deep strength asphalt concrete sections, and one of the cement treated base sections are omitted from the analysis.

It is realized this equation is subject to a number of reservations, the principal of which is that terminal serviceability is not equal at the time of resurfacing.

However, on the positive side it can be said that in practice terminal serviceability is subject to the same kinds of forces which might delay or accelerate resurfacing as was observed at the Brampton Test Road.

If the equation is used in future design work, it will form one of a number of different lines representing different subgrade types and conditions. The subgrade type for this line is a light clay, on the dry side of optimum moisture condition. Follow-up work is needed in this area.

The base equivalency values shown in Figure 4 are compared in Table 5 with base equivalencies determined previously through deflection measurements and elastic layer analyses. The most interesting feature of the comparison is the increase shown for the equivalency of asphalt concrete for that portion of the thickness greater than 90 mm. While the results of Table 4 may be interpreted differently, there is no question that the equivalency of asphalt concrete is higher than 2.0. The selection of 3.0 for thicknesses greater than 90 mm was simply a convenient way of expressing this behaviour.

VERIFICATION OF CURRENT THICKNESS DESIGN

Current thickness design for conventional highway pavements corresponds to the design of the control Sections 35 and 36, i.e. the 5.5-6-18 design, 140 mm of pavement surfacing - 150 mm of granular base - 450 mm of granular subbase.

Both Sections 35 and 36 have survived still untouched by maintenance right up to the fall of 1980, a life of at least 15 years. While surface defects are present in both sections as reported previously, riding quality is still fair after the passage of about 1.3 million equivalent standard axles. The average life of a Kings' highway pavement in Ontario is 16.3 years. The Kings' highway system comprises about 15,500 km of main highways.

The practice of using at least 150 mm of granular base is also bourne out as a requirement to prevent excessive deformation and to retard the rate of progression of cracks.

The current trend towards use of more deep strength asphalt pavements, particularly for heavier traffic situations is supported by the finding of higher equivalency for asphalt concrete over and above 90 mm thickness.

CONCLUDING REMARKS

1. A scheme for reporting pavement distresses and pavement condition at any time has been used in this report to gain specific insights into the failure modes of various base types and thicknesses.

2. The evidence gathered here supports the form of the performance equation formulated from the AASHO Road Test data, i.e. present performance is seen to be substantially measured by pavement roughness, with significant influence due to rut depth and alligator cracking.

3. Development of lines similar to that in Figure 4 for other subgrade types and conditions is needed to establish a simplified design chart for Ontario. The most acceptable approach to this task is likely to be either through examination of past records, always a difficult task, or more likely through a program of elastic layer analysis.

4. These results and observations were made on a road constructed specifically as a test, and caution must be exercised in extending those results in practice.

RECOMMENDATIONS

1. The higher equivalance of asphalt concrete in deep strength asphalt construction suggests there is a sound basis for future construction of this nature in spite of the rising cost of asphalt cement. This situation must receive further detailed examination.

2. The pavement condition scheme used successfully in this report to gain insights into failure mode, appears to have merits as a means of studying the relationship of distress to performance. It is recommended that the scheme, or some similar standarized approach be adopted for use in future distress to performance studies.

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TABLE 1/ SEVERITY AND DENSITY WEIGHTS AND DESCRIPTION CODES

WEIGHT D or S	SEVERITY				DENSITY		
	DESCRIPTION	CODE	RUT DEPTH cm	CRACK* WIDTH cm	DESCRIPTION	CODE	% LENGTH OR AREA
0	VERY SLIGHT	0	<0.5	<0.7	FEW	5	<10
1	SLIGHT	1	0.5-1	0.7-1	INTERMITTENT	6	10-20
2	MODERATE	2	1 - 2	1 - 2	FREQUENT	7	20-50
3	SEVERE	3	2 - 5	2 - 3	EXTENSIVE	8	50-80
4	VERY SEVERE	4	>5	>3	THROUGHOUT	9	>80

* FOR CEMENT TREATED BASE USE 0.3 INSTEAD OF 0.7

TABLE 2/ DISTRESS WEIGHTING FACTORS AND DESCRIPTION CODES

	Pavement Distress Manifestation		Weight (W)
	Description	Code	
Surface Defects	1. Coarse Aggregate Loss	CA	3.0
	2. Ravelling	RA	3.0
	3. Flushing	FL	0.5
Surface Deformation	4. Rippling	RI	0.5
	5. Shoving	SH	0.5
	6. Wheel Track Rutting	WR	3.0
	7. Distortion	DT	3.0
Cracking	8. Longitudinal Wheel Track - single	S/LWT	1.0
	9. - multiple	M/LWT	1.5
	10. - alligator	A/LWT	3.0
	11. Midlane - single	S/ML	0.5
	12. - multiple	M/ML	1.0
	13. Centreline - single	S/CL	0.5
	14. - multiple	M/CL	1.0
	15. - alligator	A/CL	2.0
	16. Meander - single	S/ME	0.5
	17. - multiple	M/ME	1.0
	18. Pavement Edge - single	S/PE	0.5
	19. - multiple	M/PE	1.0
	20. - alligator	A/PE	1.5
	21. Transverse - partial	P/TRV	0.5
	22. - half	H/TRV	0.5
	23. - full	F/TRV	1.5
	24. - multiple	M/TRV	2.0
	25. - alligator	A/TRV	3.0
	26. Random	RD	0.5
	27. Slippage	SL	0.5

TABLE 3/ PAVEMENT CONDITION PRIOR TO RESURFACING

			PATCHING		RESURFACING			RATING	DISTRESS
SECT.	DESIGN	BASE TYPE	DATE	%	DATE	18 kip AXLES x10^3	%	RCR/DM/DI	DENSITY SEVERITY CLASS/TYPE
1	3.5-2-0	ASPHALT CONCRETE			71/08	413	100	2.9/28/49	92 WR 62 S/ML 92 A/PE
2	3.5-4-0				71/08	413	50	5.5/18/70	92 WR 50 S/LWT 50 A/PE
5	3.5-6-0				78/08	1200	50	5.3/21/68	91 WR 82 S/LWT 71 P/TRV
3	3.5-8-0		77/08	40	79/05	1300	0	5.1/18/67	91 WR 61 P/TRV 52 F/TRV
6	3.5-2-6	ASPHALT CONCRETE	73/06	25	73/08	606	100	3.0/28/50	82 WR 62 A/LWT 80 A/PE 50 H/TRV
7	3.5-4-6				78/08	1200	100	4.6/21/63	91 WR 71 S/LWT 61 S/PE 51 P/TRV 51 F/TRV
8	3.5-4-6		71/08	10	78/08	1200	100	4.3/19/62	91 WR 71 S/LWT 51 S/ML 51 M/PE 50 P/TRV
4	3.5-6-6				79/05	1300	0	5.1/24/66	91 WR 92 S/LWT 61 F/TRV

TABLE 3/ CONTINUED

SECT.	DESIGN	BASE TYPE	PATCHING DATE	PATCHING %	RESURFACING DATE	RESURFACING 18 kip AXLES x10³	RATING %	RATING RCR/DM/DI	DISTRESS DENSITY SEVERITY CLASS/TYPE
13	3.5-2-6	CRUSHED ROCK	70/05	60	70/05	320	100	2.5/42/43	91 WR 62 A/LWT 83 A/TRV
12	3.5-4-6		68/11 70/05	20 40	70/05	320	100	3.2/40/50	91 WR 72 A.LWT 72 A/TRV 61 P/TRV
9	3.5-6-6				71/08	413	100	3.0/40/48	92 WR 61 F/TRV 61 M/TRV 73 A/TRV
10	3.5-6-6		70/06	28	71/08	413	100	4.2/29/59	91 WR 51 P/TRV 60 M/TRV 72 A/TRV
14	3.5-8-6		70/05	22	71/08	413	45	3.6/21/56	91 WR 51 P/TRV 52 A/TRV
15	3.5-2-18	CRUSHED ROCK	73/06	30	73/08	606	100	3.0/21/51	92 WR 51 S/LWT 50 S/CL 71 P/TRV 51 H/TRV
11	3.5-4-18				74/07	705	100	5.5/17/70	91 WR 61 S/LWT 50 P/TRV 51 H/TRV
36	5.5-6-18				79/05	1300	0	4.4/27/60	91 WR 81 S/LWT 61 S/ML 82 S/PE 62 F/TRV

TABLE 3/ CONTINUED

SECT.	DESIGN	BASE TYPE	PATCHING DATE	PATCHING %	RESURFACING DATE	RESURFACING 18 kip AXLES x10^3	RESURFACING %	RATING RCR/DM/DI	DISTRESS DENSITY SEVERITY CLASS/TYPE
17	3.5-2-18	CRUSHED GRAVEL			73/08	606	100	4.7/19/64	92 WR 60 P/TRV 61 H/TRV
21	3.5-4-18				75/05	796	100	5.0/20/66	92 WR 71 S/PE 51 S/LWT
16	5.5-2-18				73/08	606	100	5.0/15/67	91 WR 50 P/TRV
35	5.5-6-18				79/05	1300	0	4.5/21/63	91 WR 71 S/LWT 60 S/ML 61 F/TRV
23	3.5-2-6	CRUSHED GRAVEL			65/10	3	100		
19	3.5-4-6		70/04	20	70/05	320	100	3.6/28/55	92 WR 61 A/LWT 61 M/PE
20	3.5-4-6		70/04	20	70/05	320	100	3.0/28/50	92 WR 71 A/LWT 71/ S/PE
22	3.5-6-6		69/07	10	70/05	320	55	3.3/39/50	92 WR 72 A/LWT 71 A/TRV
24	3.5-8-6		70/05	30	71/08	413	70	3.2/26/52	91 WR 60 S/LWT 91 M/TRV
18	5.5-2-6				70/05	320	80	4.5/21/63	91 WR 51 P/TRV 52 A/LWT

TABLE 3/ CONTINUED

SECT.	DESIGN	BASE TYPE	PATCHING DATE	PATCHING %	RESURFACING DATE	RESURFACING 18 kip AXLES x10^3	RESURFACING %	RATING RCR/DM/DI	DISTRESS DENSITY SEVERITY CLASS/TYPE
25	3.5-4-6	BITUM. STAB	70/05 71/04	20 20	71/08	413	80	3.0/30/50	91 WR 50 S/LWT 72 A/LWT
26	3.5-6-6		71/04	15	71/08	413	75	4.2/20/61	91 WR 70 S/LWT 60 P/TRV 51 A/TRV
29	3.5-6-6		72/07	35	73/08	606	100	3.0/34/49	92 WR 60 S/LWT 82 A/TRV
27	3.5-8-6				73/08	606	100	4.3/21/61	50 SH 91 WR 50 S/CL 50 P/TRV 52 A/TRV
28	3.5-4-0		68/11	30	70/05	320	100	2.0/42/39	93 WR 84 A/LWT
32	3.5-4-0	CEMENT TREATED	70/05	30	70/05	320	100	3.7/34/54	91 WR 73 S/LWT 71 F/TRV
30	3.5-4-6				71/08	413	75	4.7/35/61	91 WR 72 S/LWT 52 M/LWT 82 F/TRV 62 M/TRV
31	3.5-4-6		71/08	35	72/07	500	65	2.6/34/45	92 WR 60 S/LWT 82 A/LWT 60 P/TRV
33	3.5-6-6		70/05	20	73/08	606	100	4.7/23/64	91 WR 91 S/LWT 52 F/TRV
34	3.5-8-6				71/08	413	100	4.2/36/58	90 WR 92 M/LWT 62 M/TRV 71 A/TRV

TABLE 4/ GRAVEL EQUIVALENCIES vs AXLES AT RESURFACING

SECT. NO.	DESIGN	BASE TYPE	RESURFACING DATE	AGE YRS.	18k AXLES x 10^3	EQUIVALENT THICKNESSES, H_e mm(inches) See Note 1	See Note 2
23	3.5-2-6	C. Grav	65/10	L1	3	13	13**
13	3.5-2-6	C. Rock	70/05	5	320	13	13
12	3.5-4-6	C. Rock	70/05	5	320	15	15
19&20	3.5-4-6	C. Grav	70/05	5	320	15	15
22	3.5-6-6	C. Grav	70/05	5	320	17	17
18	5.5-2-6	C. Grav	70/05	5	320	17	19
28	3.5-4-0	Bit.St.	70/05	5	320	11	12.2
32	3.5-4-0	Cem.Tr.	70/05	5	320	15	14.2
1	3.5-2-0	A.C.	71/08	6	413	11	13
2	3.5-4-0	A.C.	71/08	6	413	15	19
9&10	3.5-6-6	C. Rock	71/08	6	413	17	17
14	3.5-8-6	C. Rock	71/08	6	413	19	19
24	3.5-8-6	C. Grav	71/08	6	413	19	19
25	3.5-4-6	Bit.St.	71/08	6	413	15	16.2
26	3.5-6-6	Bit.St.	71.08	6	413	17	18.8
30	3.5-4-6	Cem.Tr.	71/08	6	413	19	18.2
34	3.5-8-6	Cem.Tr.	71/08	6	413	27	25.4**
31	3.5-4-6	Cem.Tr.	72/07	7	500	19	18.2
6	3.5-2-6	A.C.	73/08	8	606	15	17
15	3.5-2-18	C. Rock	73/08	8	606	21	21
17	3.5-2-18	C. Grav	73/08	8	606	21	21
16	5.5-2-18	C. Grav	73/08	8	606	25	27
29	3.5-6-6	Bit.St.	73/08	8	606	17	18.8
27	3.5-8-6	Bit.St.	73/08	8	606	19	21.4
33	3.5-6-6	Cem.Tr.	73/08	8	606	23	21.8
11	3.5-4-18	C. Rock	74/07	9	705	23	23
21	3.5-4-18	C. Grav	75/05	10	796	23	23
5	3.5-6-0	A.C.	78/08	13	1200	19	25
7	3.5-4-6	A.C.	78/08	13	1200	19	23
8	3.5-4-6	A.C.	78/08	13	1200	19	23
*3	3.5-8-0	A.C.	79/05	14+	1300	23	31
*4	3.5-6-6	A.C.	79/05	14+	1300	23	29
*36	5.5-6-18	C. Rock	79/05	14+	1300	29	29
*35	5.5-6-18	C. Grav	79/05	14+	1300	29	29

* Not yet resurfaced ** Not used in regression

Gravel equivalents used are:

	Note 1	Note 2
Crushed Gravel	1.0	1.0
Crushed Rock	1.0	1.0
Bitum. Stabilized	1.0	1.3
Cement Treated	2.0	1.8
Asphalt Concrete	2.0	2.0 (90 mm or less) 3.0 (more than 90 mm)

TABLE 5/ COMPARISON OF GRAVEL EQUIVALENCIES

LAYER MATERIAL	GRAVEL BASE EQUIVALENCY FROM DEFLECTION MEASUREMENTS (REF.4)					LAYER ANALYSIS METHOD	N AT RESURFACING	CURRENT PRACTICE
	1966	1967	1968	1969	1970	(REF.6)	(FIG.4)	(REF.9)
CRUSHED ROCK BASE	1.06	0.75	0.73	0.90	0.98	1.0	1.0	1.0
BITUMINOUS STABILIZED SAND BASE	1.3	1.08	1.0	0.95	1.05	1.1	1.3	1.0
CEMENT TREATED SAND BASE	3.8	3.5	2.0	1.89	3.0	---	1.8	2.0
ASPHALT CONCRETE-CONVENTIONAL & DEEP STRENGTH	1.79	1.75	1.14	2.12	2.8	2.0	90mm or less -2.0, more than 90mm-3.0	2.0
FULL-DEPTH						3.4		
SAND SUBBASE	0.59	0.52	0.54	0.62	0.73	0.6	0.67	0.67

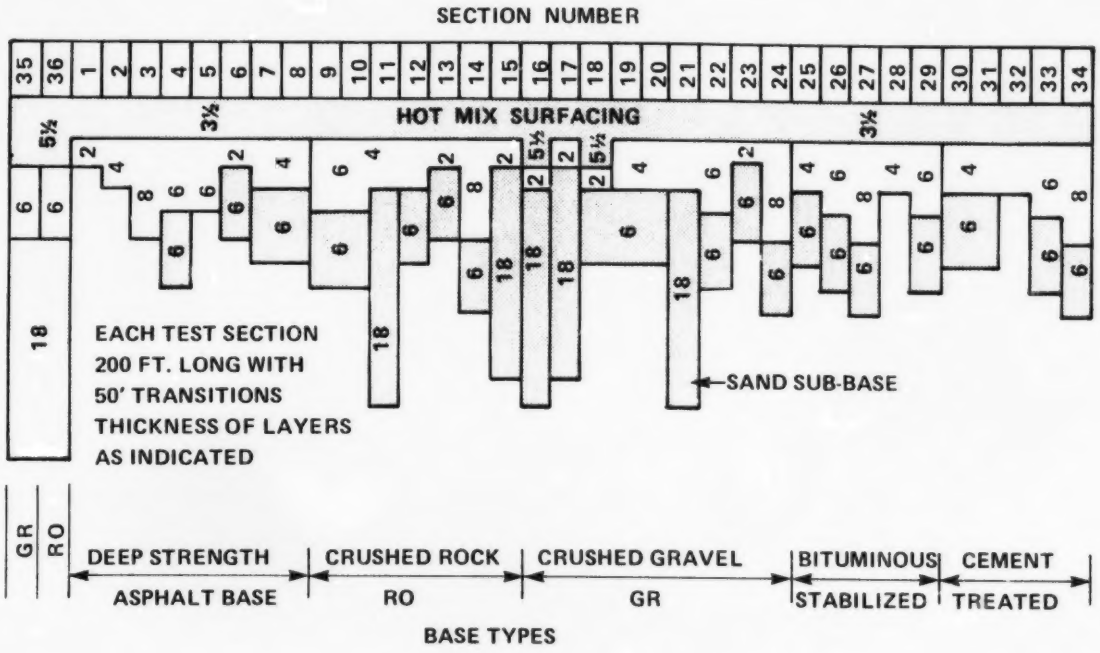


Figure 1/ Layout of Brampton Test Road – Experimental Sections

Ministry of Transportation and Communications
Ontario

PCR

URGENCY RATING	
	DELAY
	SLIGHTLY DELAY
	NO CHANGE
	SLIGHTLY ACCELERATE
	ACCELERATE

FLEXIBLE PAVEMENT CONDITION EVALUATION FORM

DISTRICT No. ____ HWY No ____ WP/CONTRACT No. ____ WP/CONTRACT LENGTH ____ (km)

LOCATION BRAMPTON TEST ROAD DATE OF SURVEY MAY 1970

NUMBER OF EVALUATION SECTIONS ____ EVALUATION SECTION No. ____ LENGTH OF EVALUATION SECTION ____ (km)

LHRS No. ____ (BEGINS) ____ (ENDS) OFFSET DISTANCE OF SECTION (km) ____ (BEGINS) ____ (ENDS)

PAVEMENT: SURFACE TYPE ____ WIDTH ____ (m) SHOULDER: SURFACE TYPE ____ WIDTH ____ (m)

RIDING COMFORT RATING (AT 80 km/h)	EXCELLENT 9 8	GOOD 7 6	FAIR 5 4	POOR 3 2	VERY POOR 1

PAVEMENT DISTRESS MANIFESTATIONS		SEVERITY OF PAVEMENT DISTRESS: 1 VERY SLIGHT	2 SLIGHT	3 MODERATE	4 SEVERE	5 VERY SEVERE	DENSITY OF PAVEMENT DISTRESS (EXTENT OF OCCURRENCE): 6 FEW < 10%	7 INTERMITTENT 10 20 %	8 FREQUENT 20 50 %	9 EXTENSIVE 50 80 %	10 THROUGHOUT 80 100 %	CHARACTERISTICS OF PAVEMENT DISTRESSES: REFLECTION CRACKING	PAVEMENT EDGE CRACK: PROGRESSIVE (< 30 cm from edge)	PAVEMENT EDGE CRACK: NON PROGRESSIVE (> 30 cm from edge)	TRANSVERSE CRACK SPACING m	ALLIGATOR CRACKING: ALLIGATOR BLOCK SIZE mm	ALLIGATOR CRACKING: DISTORTION OF ALLIGATOR AREAS mm
SURFACE DEFECTS	1 COARSE AGGREGATE LOSS																
	2 HAVELLING																
	3 FLUSHING																
SURFACE DEFORMATION	4 RIPPLING																
	5 SHOVING																
	6 WHEEL TRACK RUTTING			✓							✓						
	7 DISTORTION																
CRACKING	LONGITUDINAL WHEEL TRACK: 8 SINGLE																
	9 MULTIPLE																
	10 ALLIGATOR			✓					✓								
	MIDLANE: 11 SINGLE																
	12 MULTIPLE																
	CENTER LINE: 13 SINGLE																
	14 MULTIPLE																
	15 ALLIGATOR																
	MEANDER: 16 SINGLE																
	17 MULTIPLE																
	PAVEMENT EDGE: 18 SINGLE																
	19 MULTIPLE																
	20 ALLIGATOR																
	TRANSVERSE: 21 PARTIAL		✓					✓									
	22 HALF																
	23 FULL																
	24 MULTIPLE																
	25 ALLIGATOR			✓					✓								
	26 RANDOM																
	27 SLIPPAGE																
MAINTENANCE PATCHING	SPRAY																
	SKIN																
	HOT MIX																
ADDITIONAL REMARKS																	

Revised June 1978

Figure 2/ Typical Completed Work Sheet

Appendix A

Rut Depth Prediction Modes (Reference 14).

Rut Depth $RD = RD_{(5x10^5)} + \beta (1 - e^{-\tau\Delta})$

where $RD_{(5 \times 10^5)} = -1.0318 + 1.2067\ EAT + 0.0803N$

$-2.3684 \log_e EAT - 0.1896 \log_e(N.EAT)$

$+ 1.1639\ E_1 \log_e EAT - 0.0216\ E_S N$

$-0.4114\ E_1 \log_e EAT + 0.0456\ E_S N \log_e EAT$

Rut Depth is in inches (1 inch = 25.4 mm)

EAT = equivalent asphalt thickness, inches/10

E_1= elastic modulus of asphalt, psi/10^6 (1 psi=6.89 kPa)

E_S= resilient modulus of subgrade, psi/10^4

N=number of equivalent 18,000 lb. axle load applications/10^5

(18,000 lbs=80kN or '9' tonnes)

β = 10/EAT ins. (1 inch = 25.4mm)

τ = 0.02B

$\Delta = (N-5x10^5)/10^5$

FIGURE 2.2/ EXAMPLE CALCULATION OF DM AND DI FROM COMPLETED WORKSHEET IN FIGURE 2.1

Figure 2.1 shows a typical completed work sheet for reporting pavement condition of the Brampton Test Road sections. The work sheets were made up by consulting records of profilometer roughness measurements, wheel track rutting, and maps of cracks recorded at various convenient dates.

The example in Figure 2.1 indicates the following pavement conditions for Section 12, at May 1970:

1) The RCR = 3.2 (from profilometer 'q' measurements);

2) Rut depth measurements showed an average of 1.2 cms throughout the section - this is expressed as throughout moderate rutting, or in coded form, 92 WR;

3) The crack map for Section 12 in May 1970 showed alligatoring longitudinally in the outer wheel track, extending over 40% of the length of the section. The corners of the blocks in the alligator pattern had spalled, and the area was depressed more than 1 cm. This condition is expressed as frequent moderate alligator cracking longitudinally in the wheel tracks, or in coded form as 72 A/LWT:

4) In addition there were partial transverse cracks over 15% of the area of the section, and the cracks were about 0.8 cm wide. This condition is expressed as intermittent slight partial transverse cracks, or in coded form as, 61 P/TRV;

5) Also there were alligatored areas around transverse cracks which covered 30% of the area of the section. The alligator blocks had spalled edges and a depression around the transverse crack. This condition is expressed as frequent moderate alligatoring at transverse cracks, or in coded form, 72 A/TRV;

6) In coded form the distress manifestations are summarized as:

92 WR
72 A/LWT
61 P/TRV
72 A/TRV

7) The calculation of DM is as follows:
Weights (D+S) x Weight (Distress Type)
i.e. 92 WR - (4+2) x 3.0 = 18
72 A/LWT - (2+2) x 3.0 = 12
61 P/TRV - (1+1) x 0.5 = 1
72 A/TRV - (2+2) x 3.0 = 12
= 43 = DM

8) The calculation of DI is as follows:

$$DI = 100\ (0.1 \times RCR)\ 1/2 \times \frac{320 - DM}{320}$$

$$= 100\ (0.1 \times 3.2)\ 1/2 \times \frac{320 - 43}{320}$$

$$= 100 \times 0.5657 \times 0.8656 = 49$$

APPENDIX A

TABLE A1/ RUT DEPTH SUMMARY BRAMPTON TEST ROAD (INCHES)

SECT. NO.	DATE	JULY 1967	OCT 1967	APR 1968	MAY 1968	AUG 1968	NOV 1968	APR 1969	MAY 1970	MAY 1971	AUG 1971	JUNE 1972	JUNE 1973
		*x	x	x	x	x	x	x	x	x	x	x	x
1.		0.12	0.12	0.15	0.16	0.18	0.18	0.21	0.30	0.36	0.47	—	—
2.		0.11	0.12	0.14	0.15	0.16	0.17	0.20	0.29	0.38	0.50	0.46	0.54
3.		0.14	0.14	0.17	0.17	0.16	0.20	0.19	0.29	0.38	0.43	0.45	0.40
4.		0.14	0.15	0.18	0.19	0.19	0.21	0.21	0.33	0.38	0.44	0.45	0.40
5.		0.10	0.11	0.13	0.15	0.14	0.16	0.17	0.28	0.34	0.39	0.39	0.36
6.		0.32	0.34	0.36	0.39	0.37	0.39	0.43	0.53	0.54	0.62	0.59	0.63
7.		0.16	0.17	0.18	0.18	0.20	0.21	0.23	0.31	0.28	0.41	0.42	0.37
8.		0.22	0.22	0.24	0.23	0.24	0.26	0.29	0.36	0.41	0.47	0.43	0.41
9.		0.24	0.26	0.31	0.29	0.27	0.33	0.36	0.46	0.54	0.56	—	—
10.		0.21	0.21	0.23	0.23	0.24	0.26	0.28	0.37	0.26	0.29	0.35	—
11.		0.24	0.24	0.25	0.26	0.26	0.28	0.29	0.35	0.43	0.45	0.47	0.42
12.		0.22	0.24	0.28	0.32	0.31	0.33	0.50	—	—	—	—	—
13.		0.35	0.39	0.31	0.29	0.28	0.34	0.39	0.47	—	—	—	—
14.		0.14	0.14	0.17	0.16	0.17	0.16	0.20	0.29	0.32	0.24	0.31	—
15.		0.23	0.25	0.27	0.27	0.25	0.25	0.29	0.33	0.40	0.43	0.50	0.49
36.		0.10	0.09	0.11	0.12	0.12	0.13	0.14	0.23	0.28	0.33	0.33	0.28
16.		0.19	0.20	0.22	0.23	0.22	0.23	0.26	0.35	0.40	0.44	0.47	0.43
17.		0.22	0.21	0.24	0.23	0.24	0.26	0.27	0.33	0.44	0.46	0.52	0.51
18.		0.23	0.24	0.26	0.27	0.28	0.31	0.29	0.37	0.29	0.34	0.38	—
19.		0.24	0.24	0.24	0.28	0.31	0.32	0.28	0.51	—	—	—	—
20.		0.25	0.24	0.29	0.30	0.30	0.32	0.44	0.38	—	—	—	—
21.		0.15	0.17	0.19	0.21	0.21	0.21	0.23	0.32	0.42	0.46	0.51	0.47
22.		0.23	0.24	0.26	0.27	0.27	0.29	0.33	0.43	0.39	—	—	—
24.		0.21	0.24	0.29	0.28	0.28	0.22	0.33	0.42	0.40	—	—	—
35.		0.12	0.12	0.15	0.17	0.18	0.17	0.19	0.30	0.33	0.40	0.38	0.36
25.		0.16	0.17	0.22	0.21	0.22	0.24	0.22	0.34	0.42	—	—	—
26.		0.11	0.12	0.17	0.15	0.16	0.18	0.18	0.28	0.33	—	—	—
27.		0.08	0.08	0.12	0.11	0.13	0.14	0.16	0.24	0.32	0.35	0.40	0.36
28.													
29.		0.15	0.16	0.19	0.18	0.18	0.19	0.22	0.31	0.41	—	0.57	—
30.		0.14	0.14	0.18	0.18	0.19	0.20	0.24	0.31	0.43	0.42	—	—
31.		0.13	0.12	0.14	0.15	0.15	0.16	0.20	0.24	0.30	0.34	0.45	—
32.		0.24	0.12	0.16	0.16	0.18	0.17	0.24	0.33	0.21	0.26	0.32	—
33.		0.14	0.10	0.14	0.13	0.14	0.17	0.17	0.23	0.37	0.38	0.44	0.41
34.		0.11	0.07	0.09	0.07	0.08	0.09	0.14	0.19	0.30	0.29	0.25	—
Equiv. 18 KIP Axles $x10^3$		121	137	165	170	180	200	235	245	400	435	500	595

* Mean of 20 measurements in both wheel paths. 1 inch = 25.4 mm

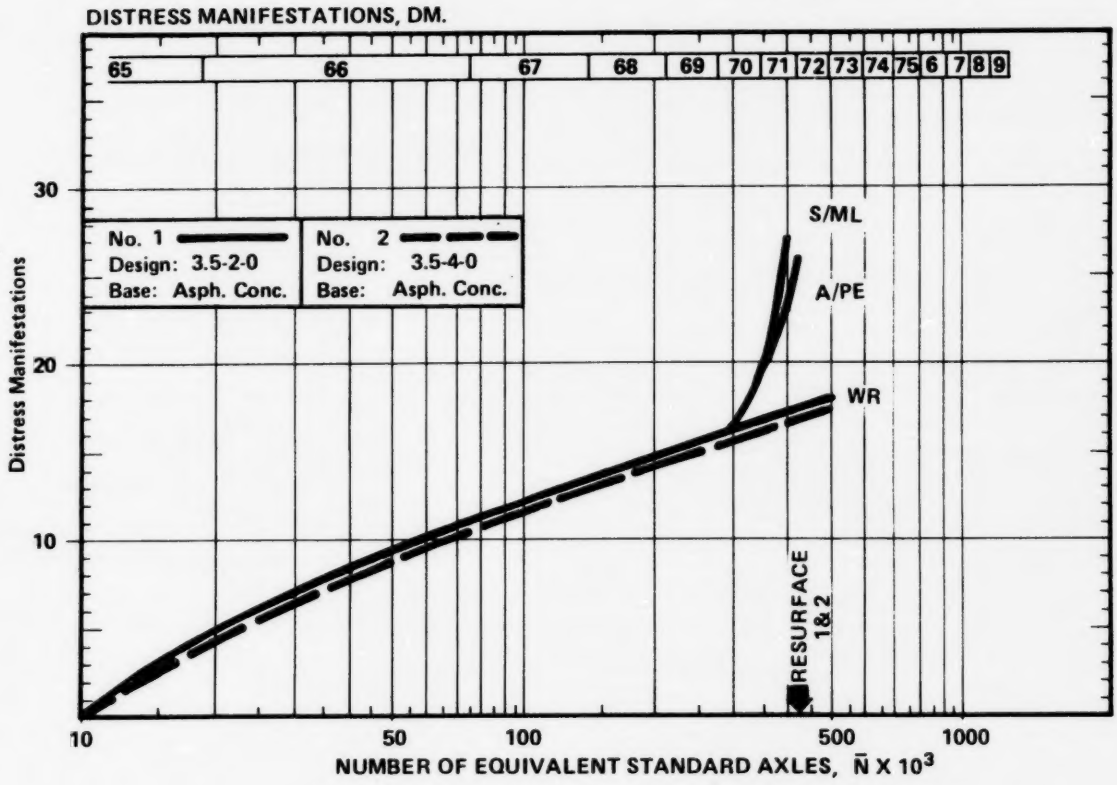


Figure 3.1 Progression of Pavement Distresses

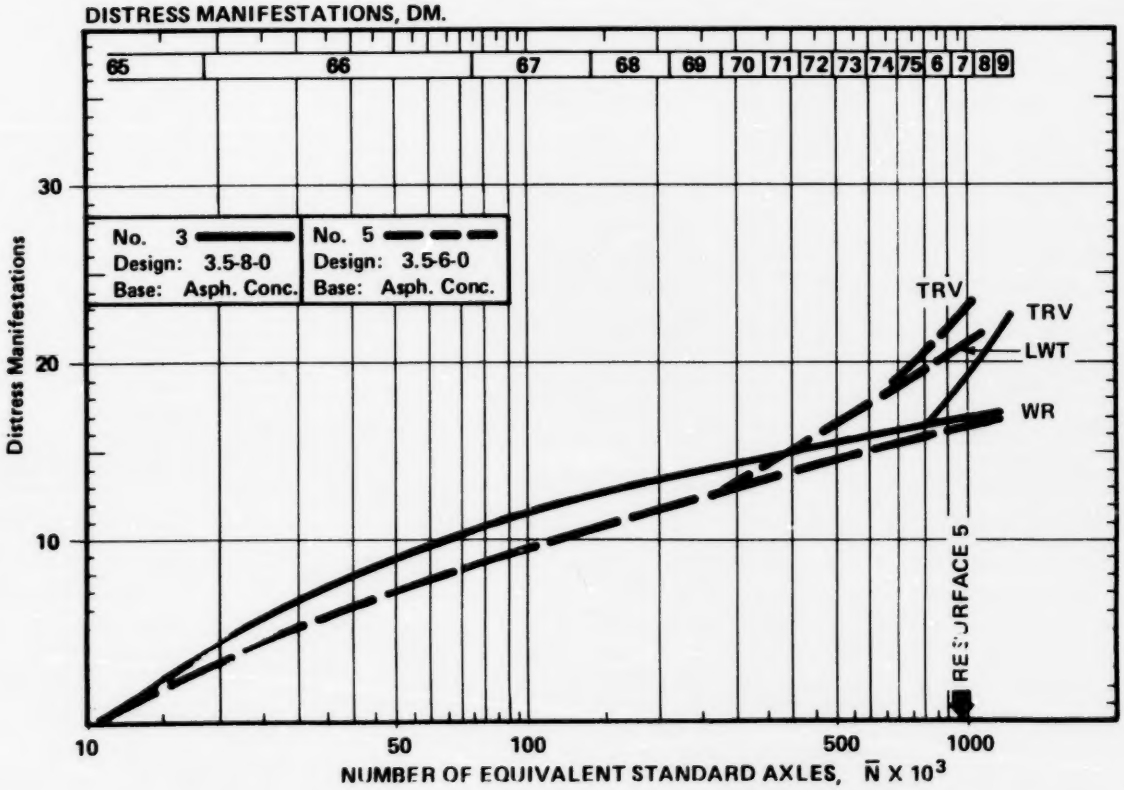


Figure 3.2 Progression of Pavement Distresses

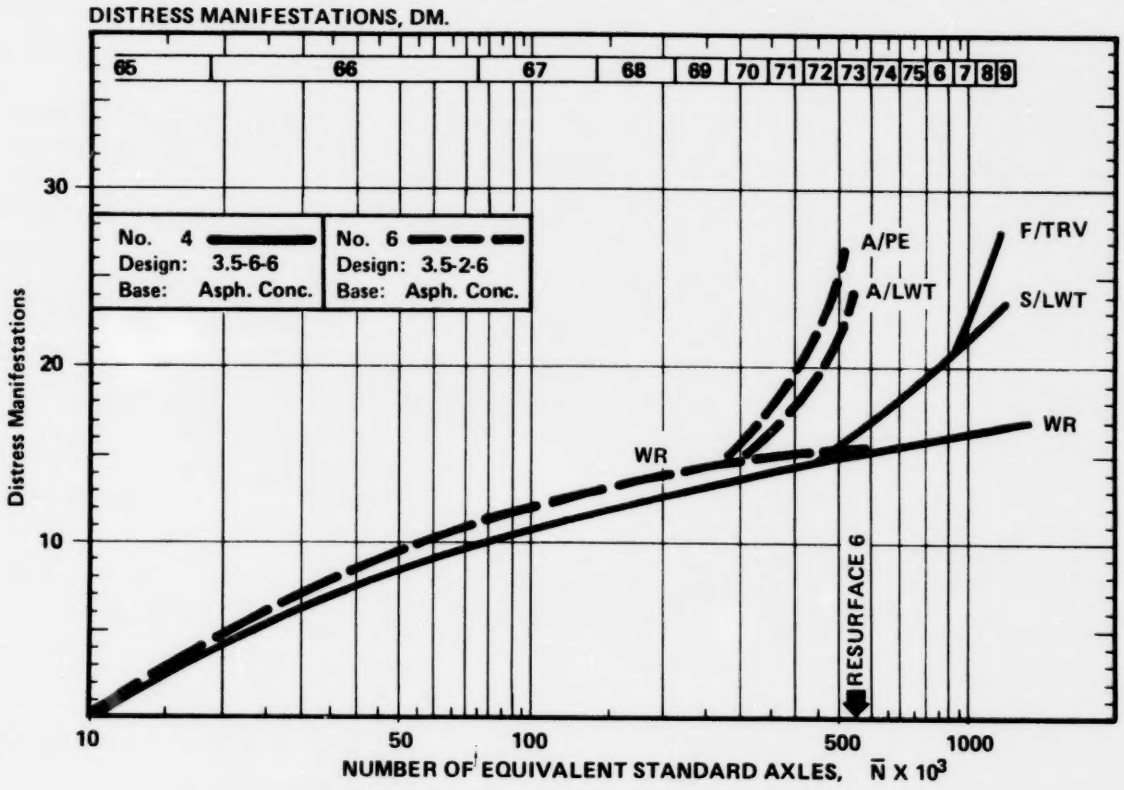


Figure 3.3 Progression of Pavement Distresses

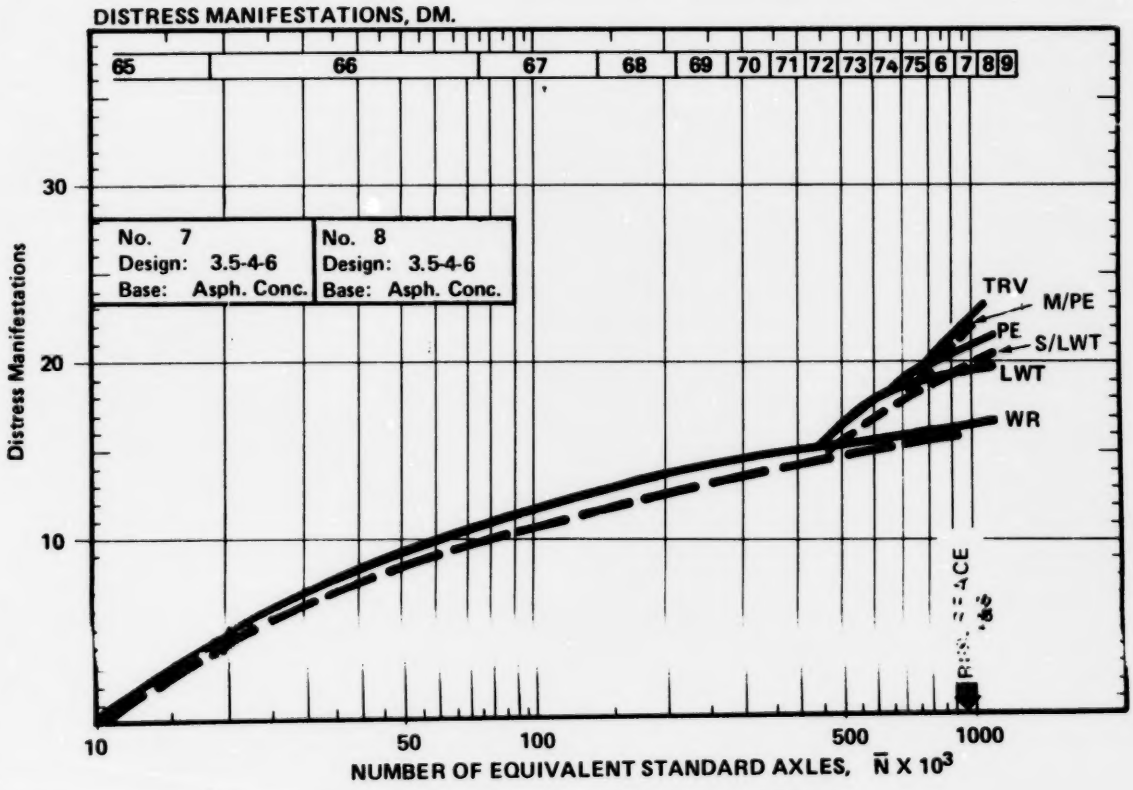


Figure 3.4 Progression of Pavement Distresses

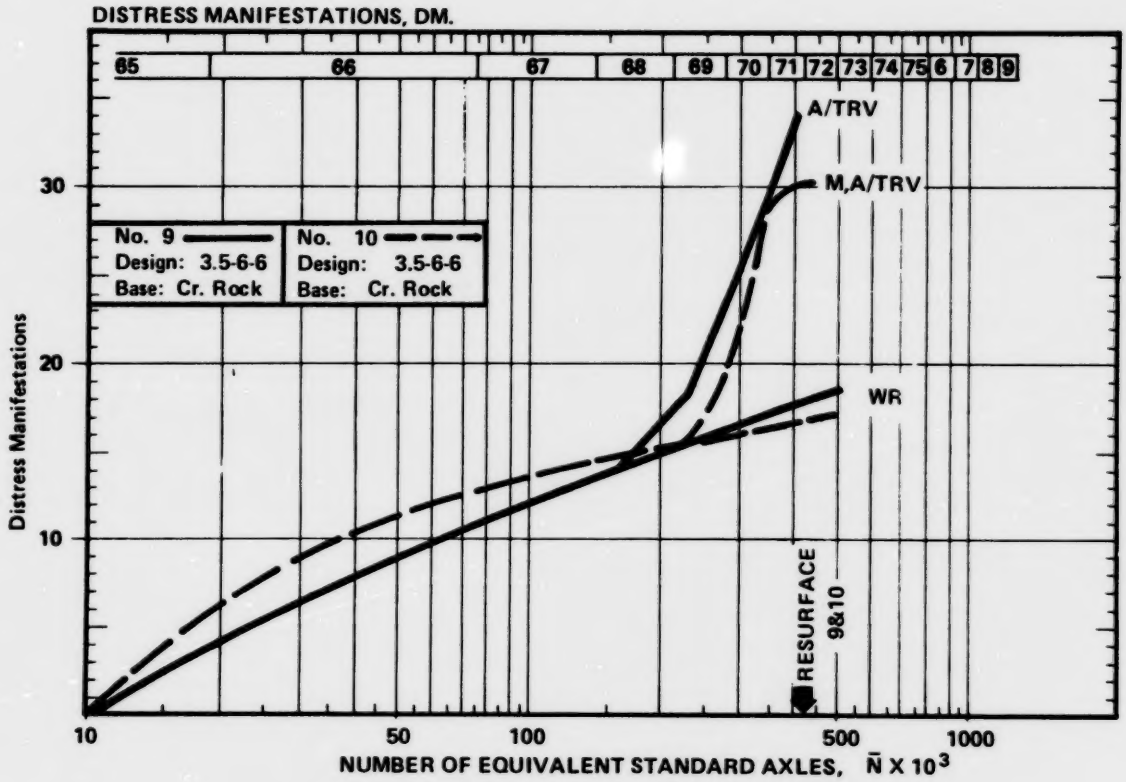


Figure 3.5 Progression of Pavement Distresses

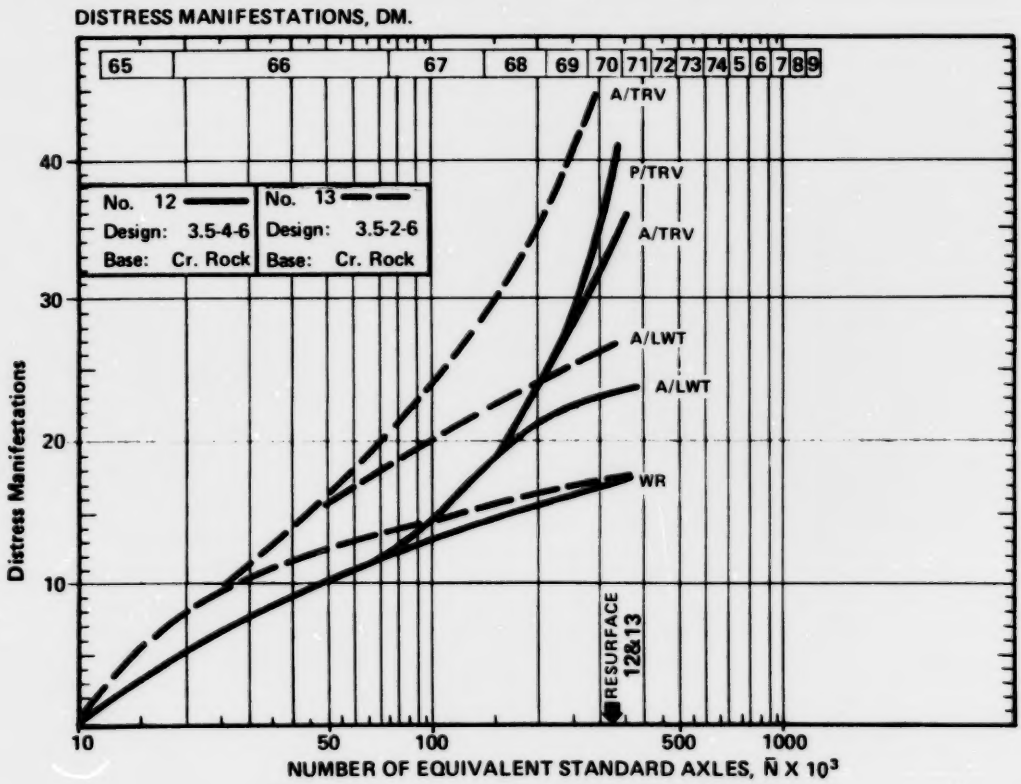


Figure 3.6 Progression of Pavement Distresses

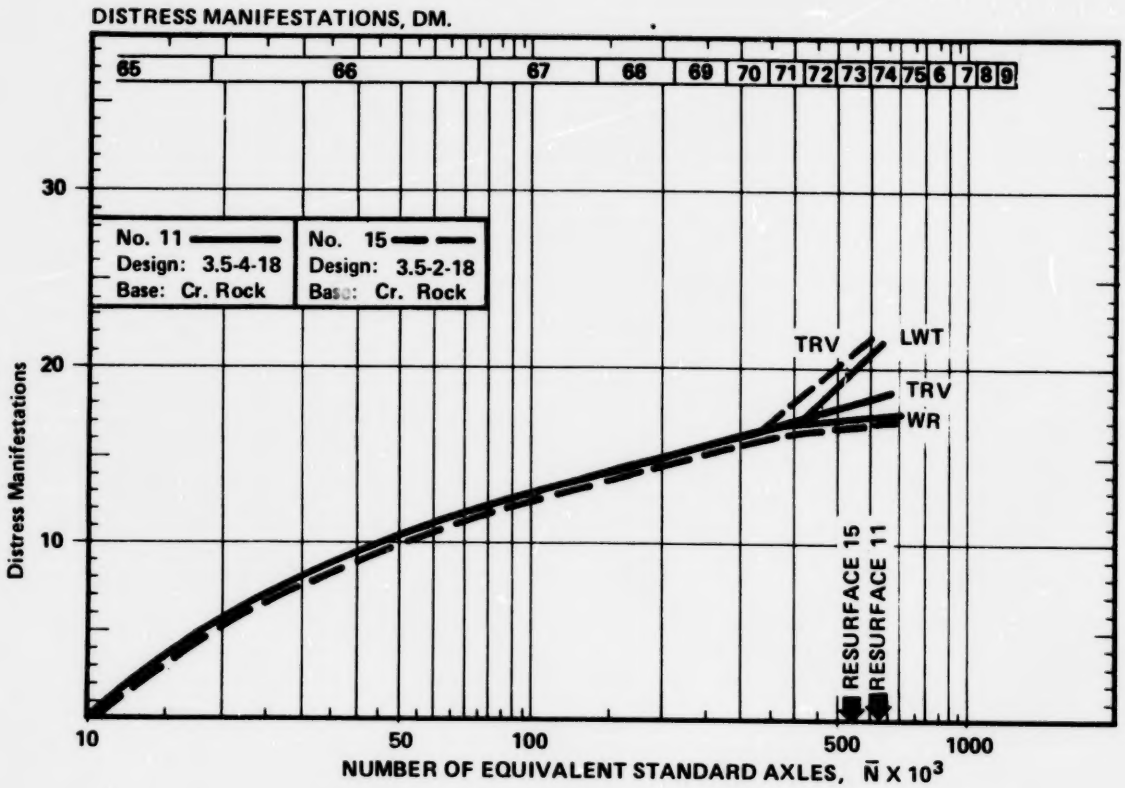


Figure 3.7 Progression of Pavement Distresses

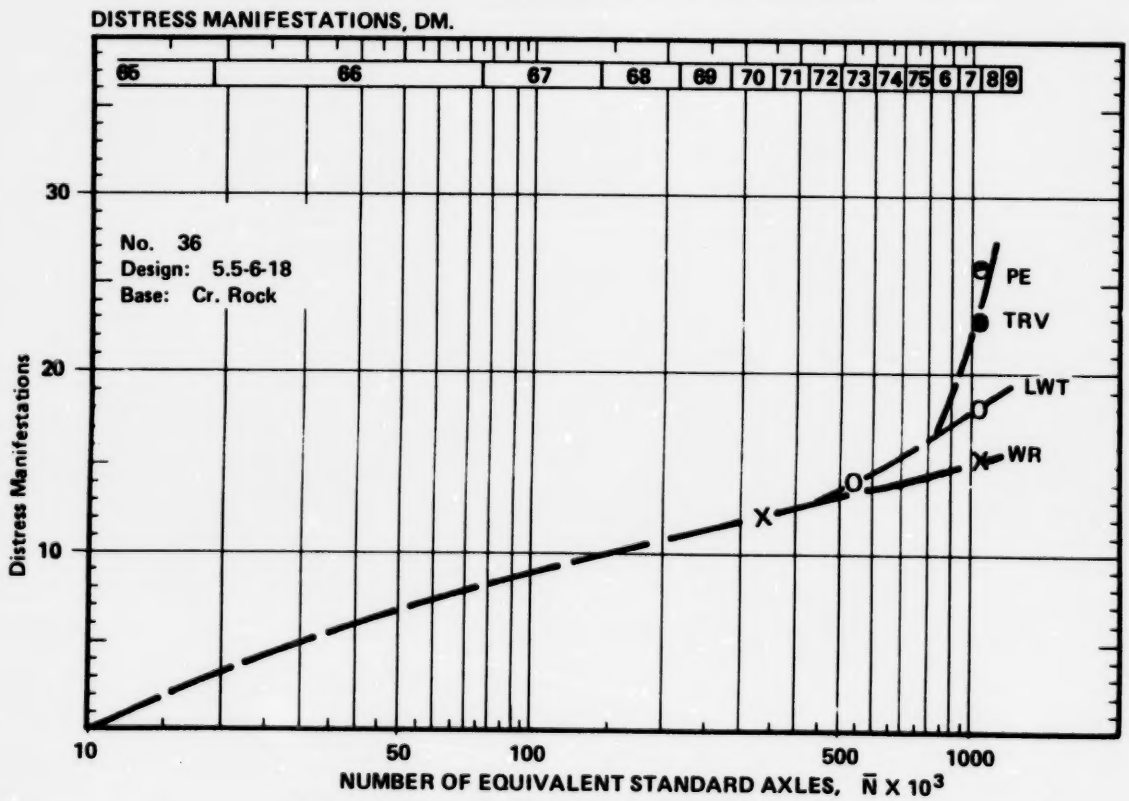


Figure 3.8 Progression of Pavement Distresses

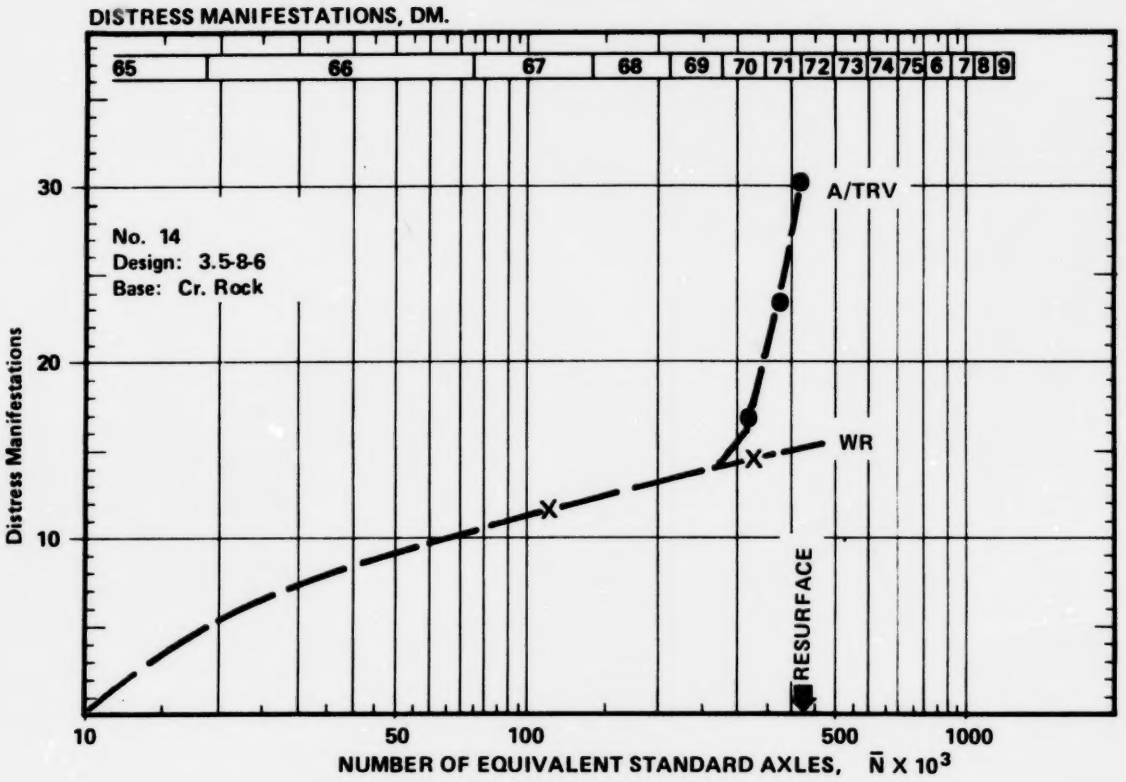


Figure 3.9 Progression of Pavement Distresses

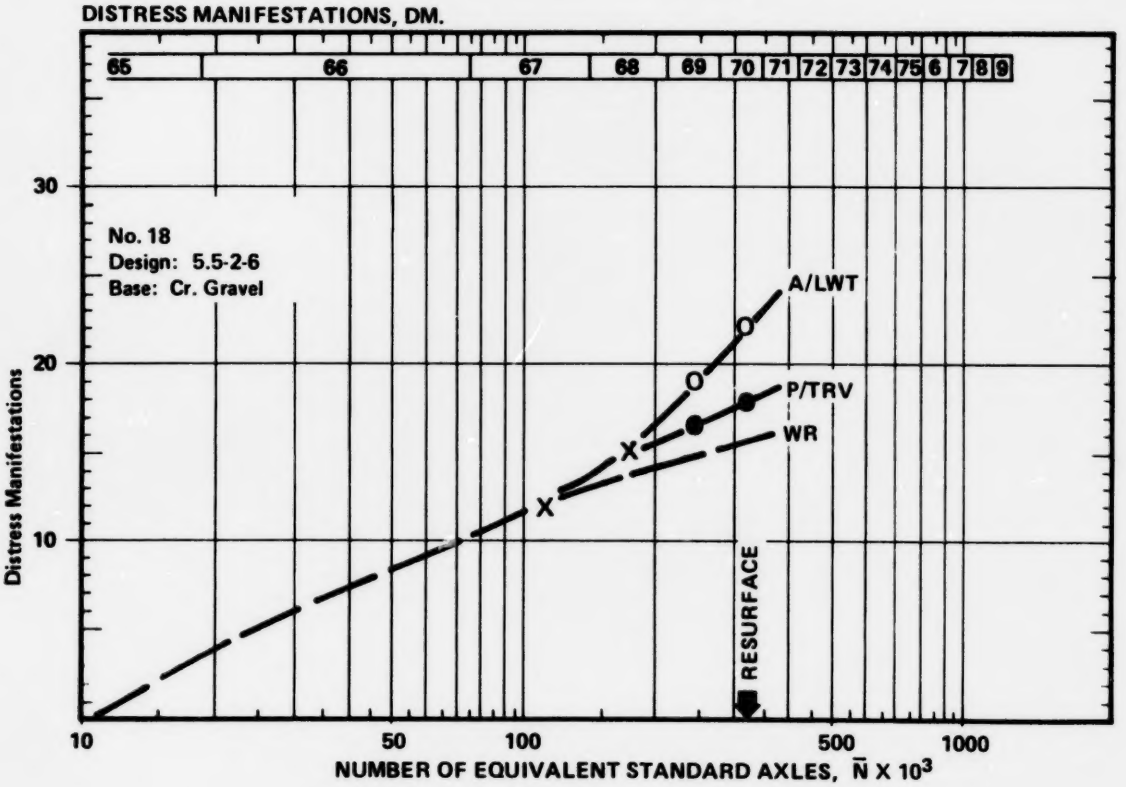


Figure 3.10 Progression of Pavement Distresses

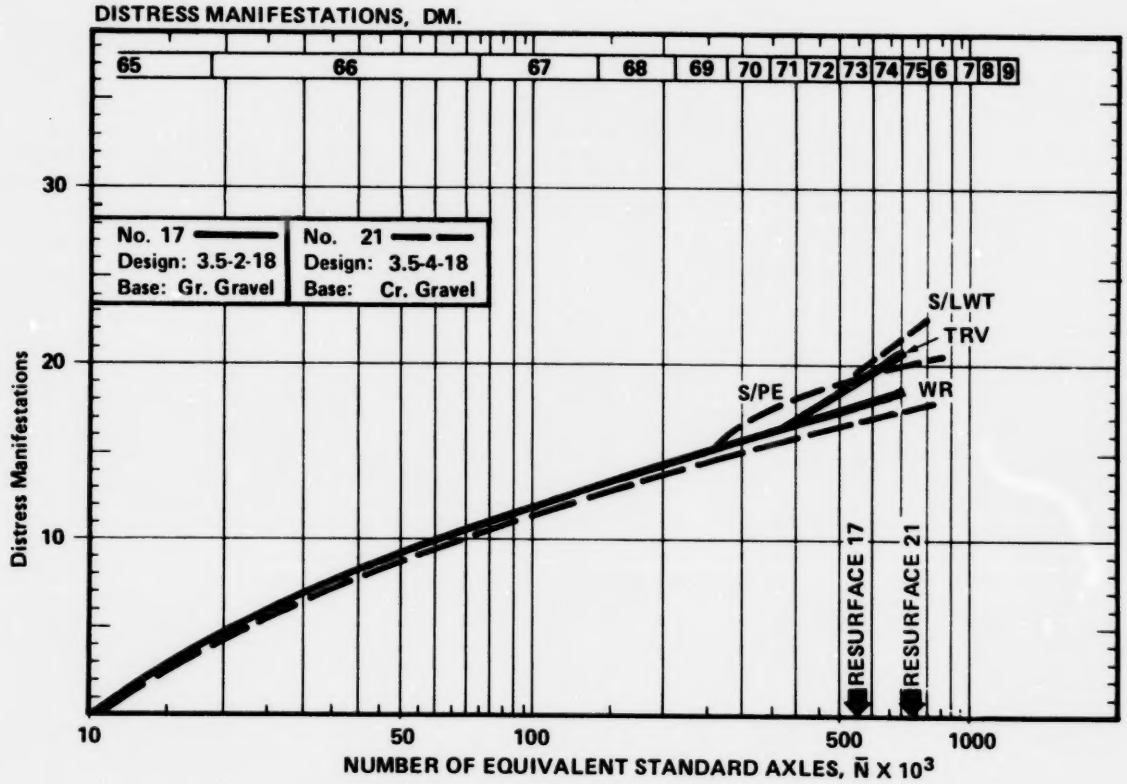


Figure 3.11 Progression of Pavement Distresses

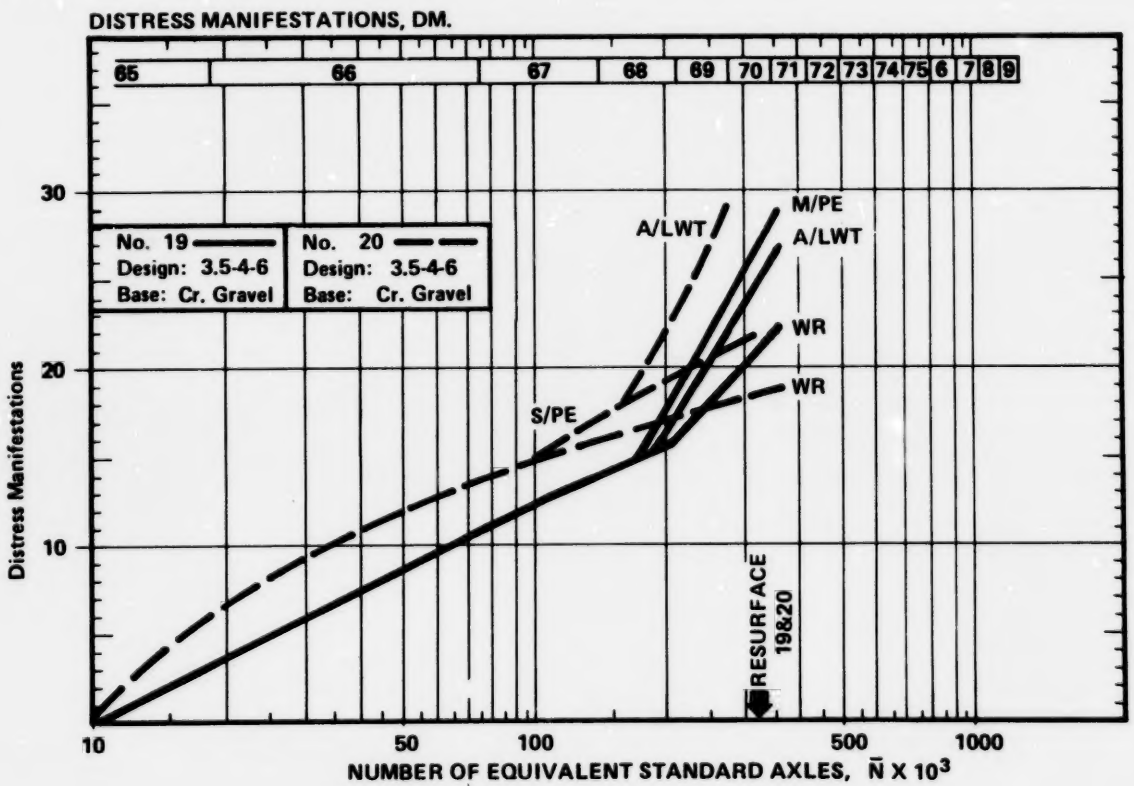


Figure 3.12 Progression of Pavement Distresses

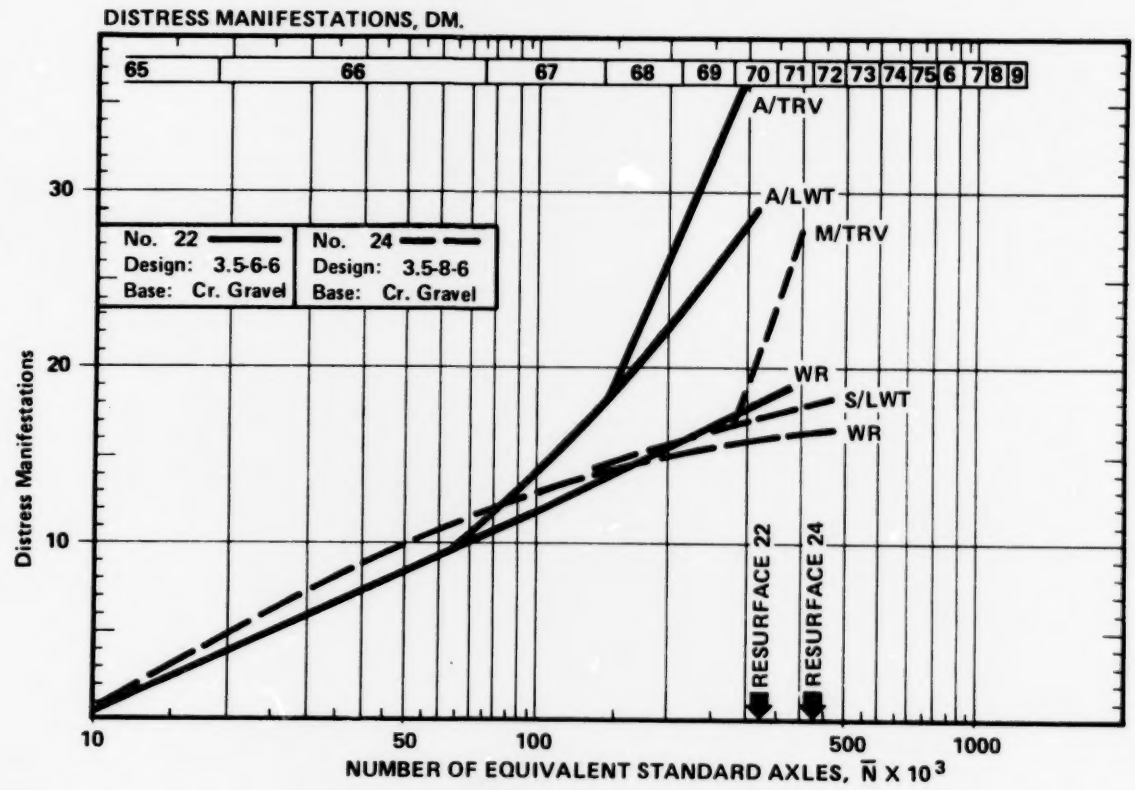


Figure 3.13 Progression of Pavement Distresses

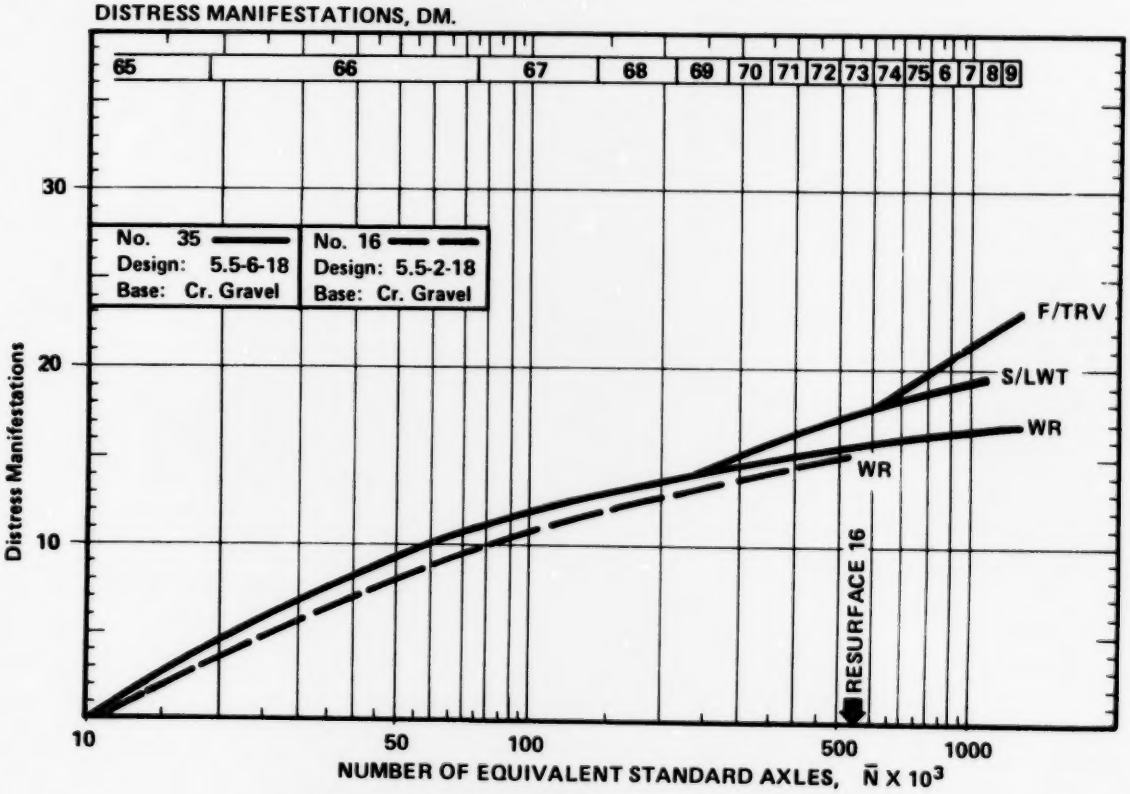


Figure 3.14 Progression of Pavement Distresses

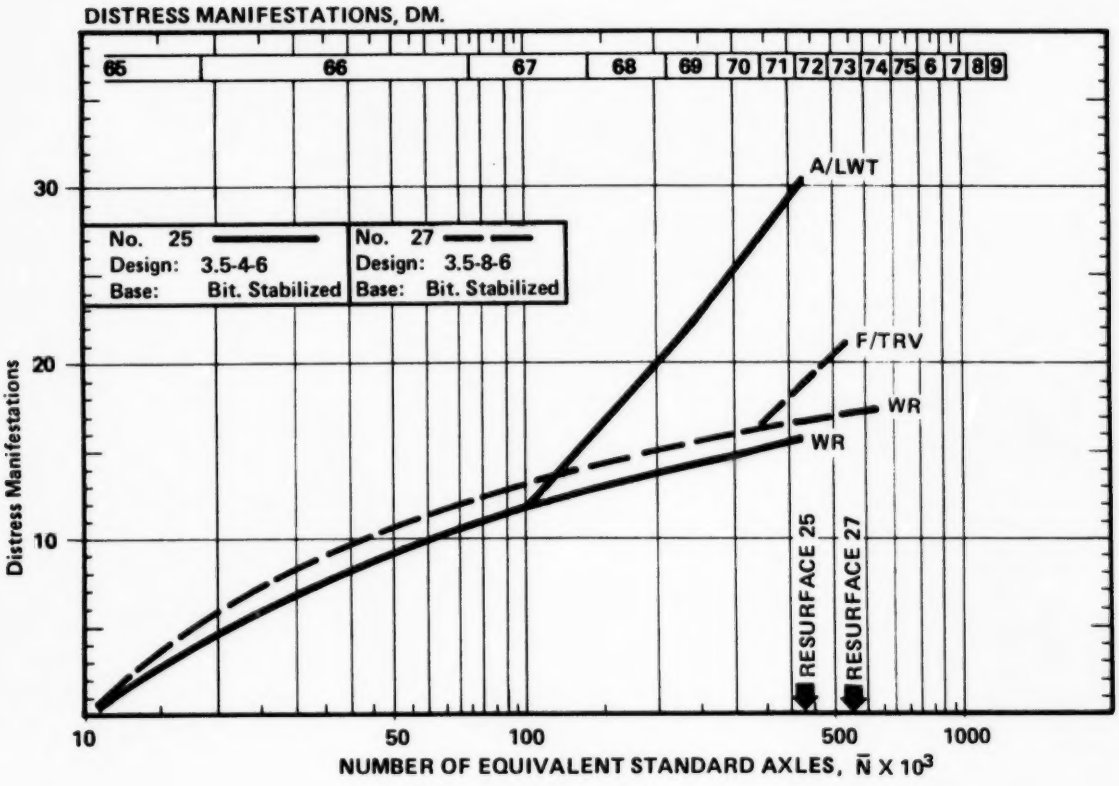


Figure 3.15 Progression of Pavement Distresses

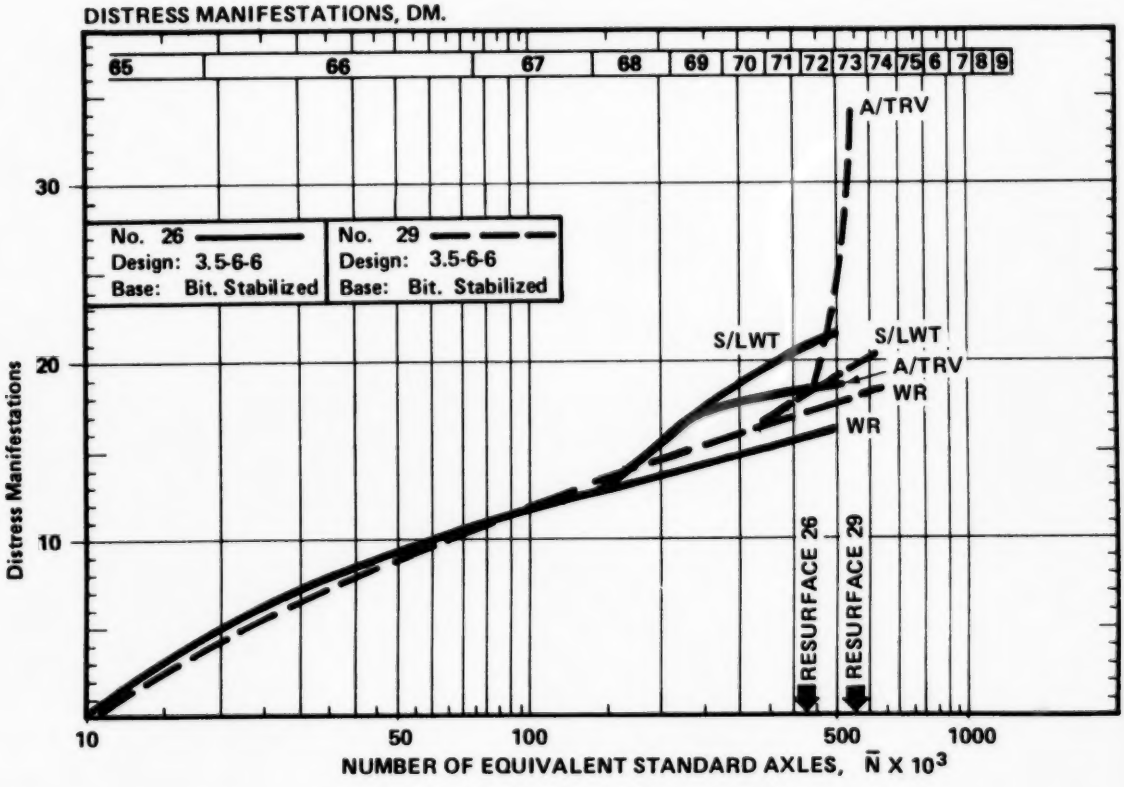


Figure 3.16 Progression of Pavement Distresses

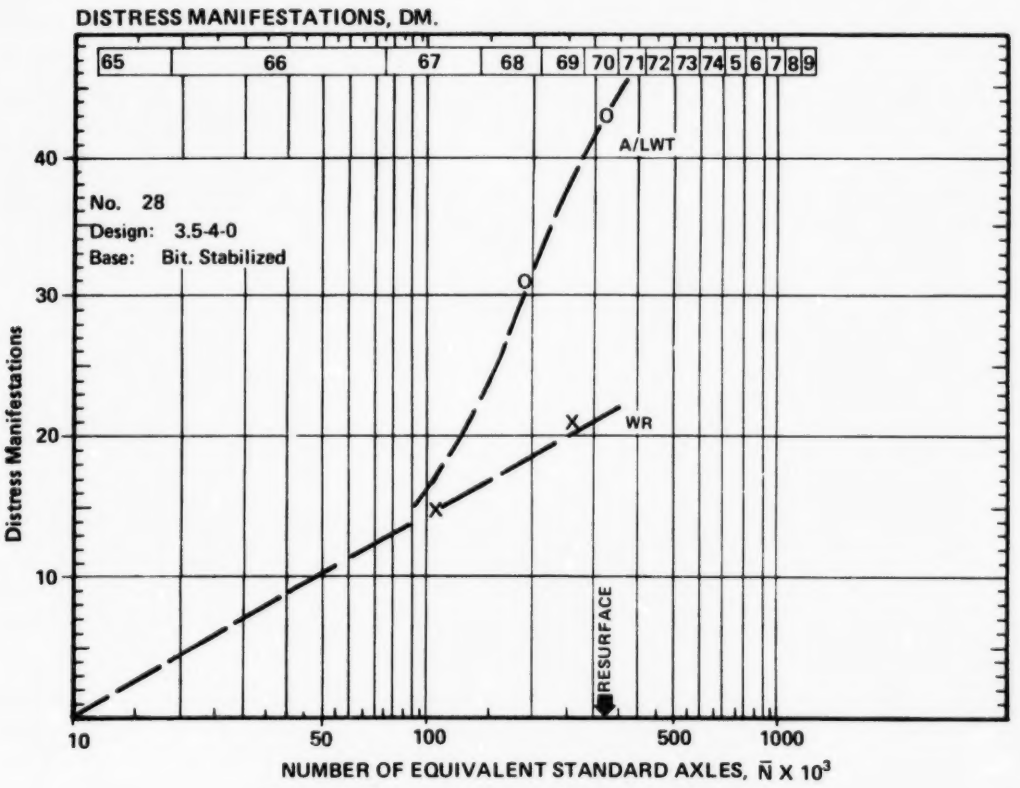


Figure 3.17 Progression of Pavement Distresses

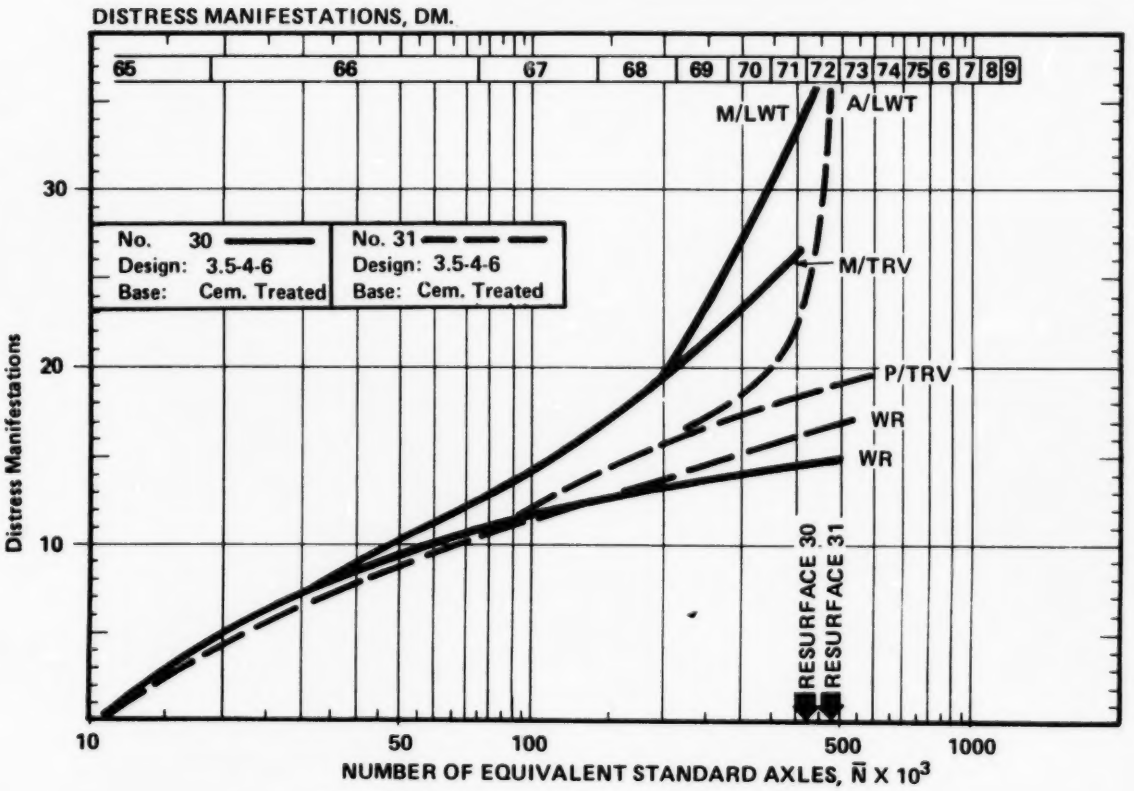


Figure 3.18 Progression of Pavement Distresses

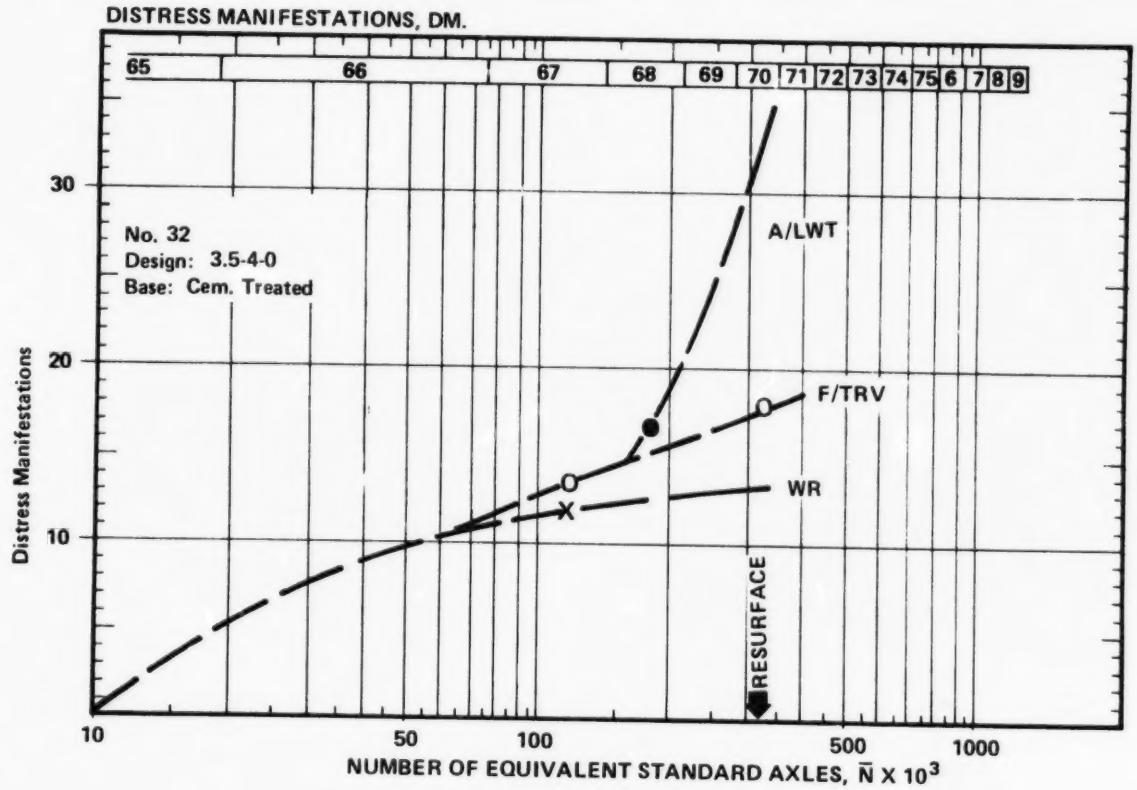


Figure 3.19 Progression of Pavement Distresses

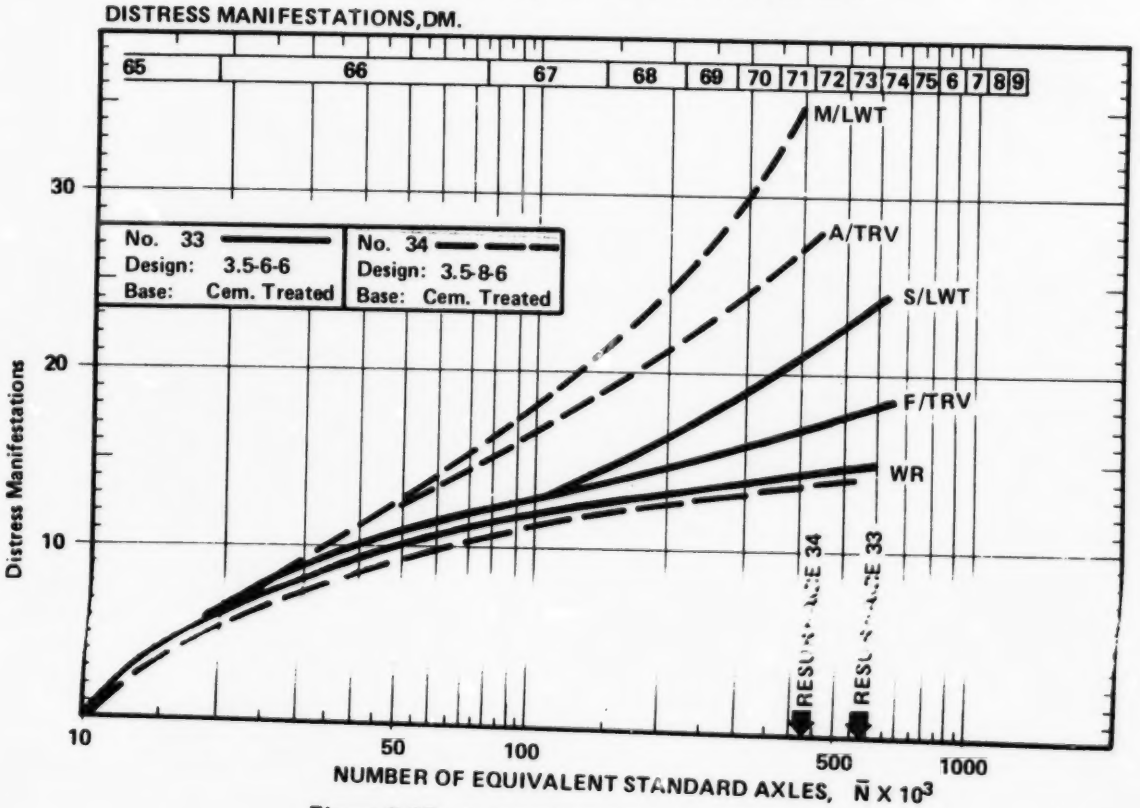
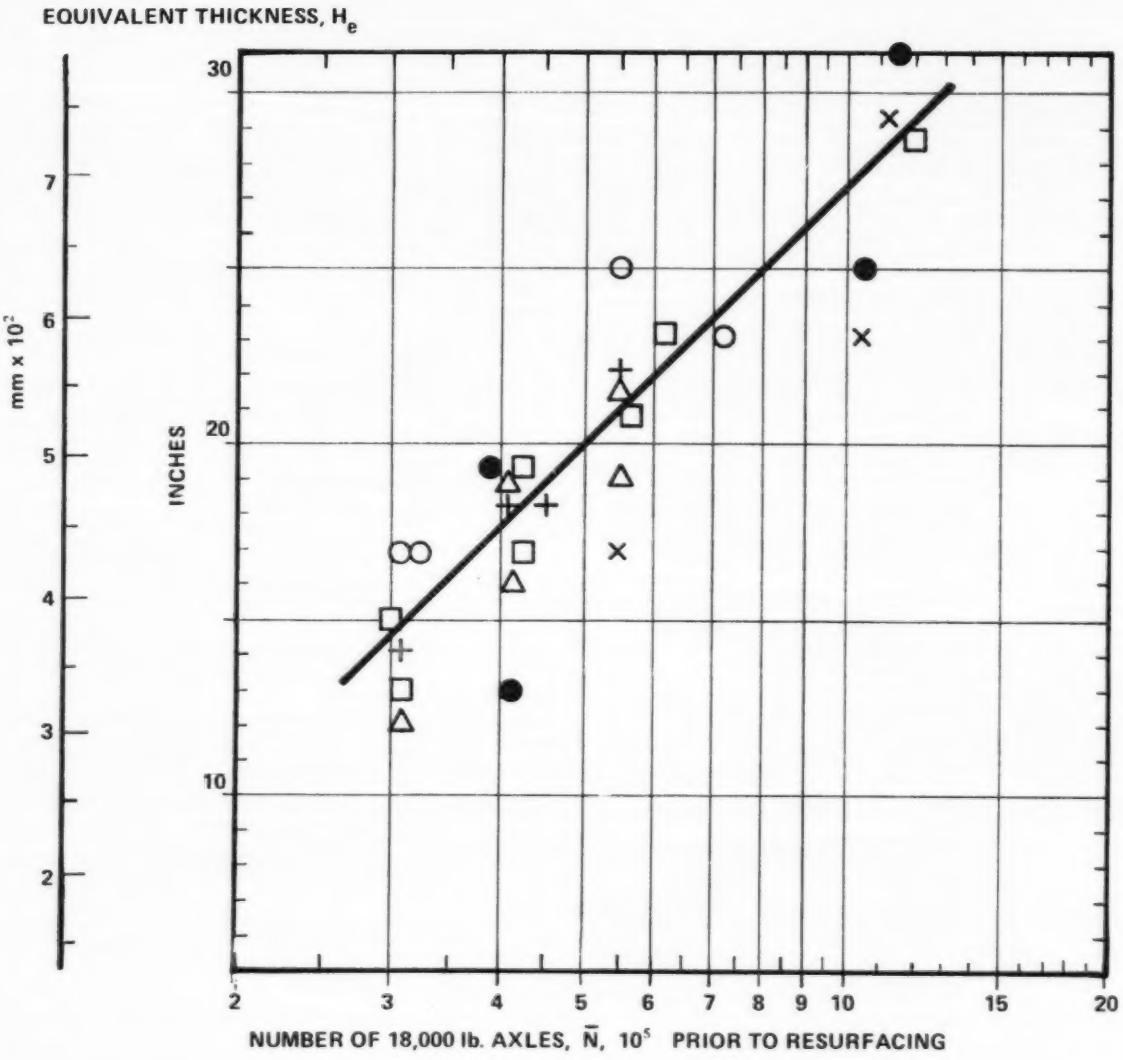


Figure 3.20 Progression of Pavement Distresses



	GRAVEL EQUIVALENT
○ CR. GRAVEL	1.0
□ CR. ROCK	1.0
△ BIT. STAB.	1.3
+ CEM. TREAT.	1.8
● ASPH. CONC. F.D.	2.0 <3.5"> 3.0
× ASPH. CONC. D.S.	2.0 <3.5"> 3.0

$H_e = -112.82 + 10.07 \ln \bar{N}$

$r^2 = 0.85$ WITHOUT D.S. ASPH. CONC.

Figure 4/ Equivalent Gravel vs. Axles to Resurfacing

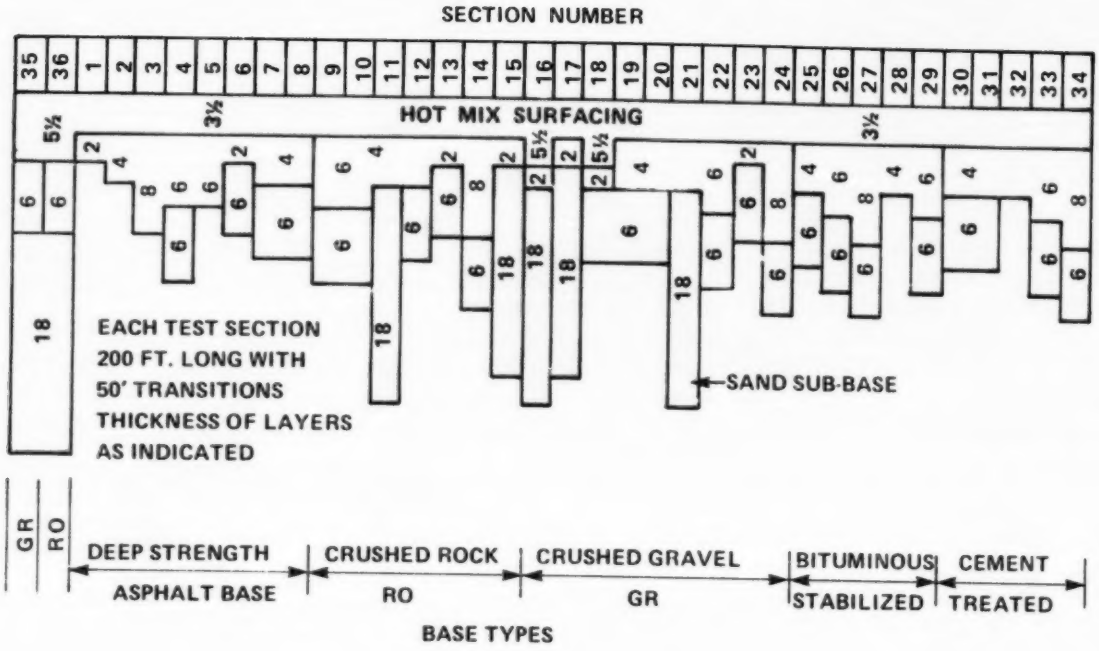


Figure 1/ Layout of Brampton Test Road – Experimental Sections

Ministry of Transportation and Communications

Ontario

PCR

URGENCY RATING	
	DELAY
	SLIGHTLY DELAY
	NO CHANGE
	SLIGHTLY ACCELERATE
	ACCELERATE

FLEXIBLE PAVEMENT CONDITION EVALUATION FORM

DISTRICT No. ____ HWY No. ____ WP/CONTRACT No. ____ WP/CONTRACT LENGTH ____ (km)

LOCATION BRAMPTON TEST ROAD DATE OF SURVEY MAY 1970

NUMBER OF EVALUATION SECTIONS ____ EVALUATION SECTION No. ____ LENGTH OF EVALUATION SECTION ____ (km)

LHRS No. ____ (BEGINS) ____ (ENDS) OFFSET DISTANCE OF SECTION (km) ____ (BEGINS) ____ (ENDS)

PAVEMENT SURFACE TYPE ____ WIDTH ____ (m) SHOULDER SURFACE TYPE ____ WIDTH ____ (m)

RIDING COMFORT RATING (AT 80 km/h)	EXCELLENT 9	8	GOOD 7	6	FAIR 5	4	POOR 3	2	VERY POOR 1

PAVEMENT DISTRESS MANIFESTATIONS		SEVERITY OF PAVEMENT DISTRESS 1 VERY SLIGHT	2 SLIGHT	3 MODERATE	4 SEVERE	5 VERY SEVERE	DENSITY OF PAVEMENT DISTRESS (EXTENT OF OCCURRENCE) 6 FEW 10%	7 INTERMITTENT 10 20 %	8 FREQUENT 20 50 %	9 EXTENSIVE 50 80 %	10 THROUGHOUT 80 100 %	CHARACTERISTICS OF PAVEMENT DISTRESSES REFLECTION CRACKING	PAVEMENT EDGE CRACK PROGRESSIVE (- 30 cm from edge)	PAVEMENT EDGE CRACK NON PROGRESSIVE (- 30 cm from edge)	ALLIGATOR CRACKING TRANSVERSE CRACK SPACING m	ALLIGATOR CRACKING ALLIGATOR BLOCK SIZE mm	ALLIGATOR CRACKING DISTORTION OF ALLIGATOR AREAS mm
SURFACE DEFECTS	1 COARSE AGGREGATE LOSS																
	2 RAVELLING																
	3 FLUSHING																
SURFACE DEFORMATION	4 RIPPLING																
	5 SHOVING																
	6 WHEEL TRACK RUTTING			✓							✓						
	7 DISTORTION																
CRACKING	LONGITUDINAL WHEEL TRACK 8 SINGLE																
	9 MULTIPLE																
	10 ALLIGATOR			✓					✓								
	MIDLANE 11 SINGLE																
	MULTIPLE																
	CENTER LINE 13 SINGLE																
	14 MULTIPLE																
	15 ALLIGATOR																
	MEANDER 16 SINGLE																
	17 MULTIPLE																
	PAVEMENT EDGE 18 SINGLE																
	19 MULTIPLE																
	20 ALLIGATOR																
	TRANSVERSE 21 PARTIAL		✓					✓									
	22 HALF																
	23 FULL																
	24 MULTIPLE																
	25 ALLIGATOR			✓					✓								
	RANDOM																
	SLIPPAGE																
MAINTENANCE PATCHING	SPRAY																
	SKIN																
	HOT MIX																
ADDITIONAL REMARKS																	

Revised June 1978

Figure 2/ Typical Completed Work Sheet

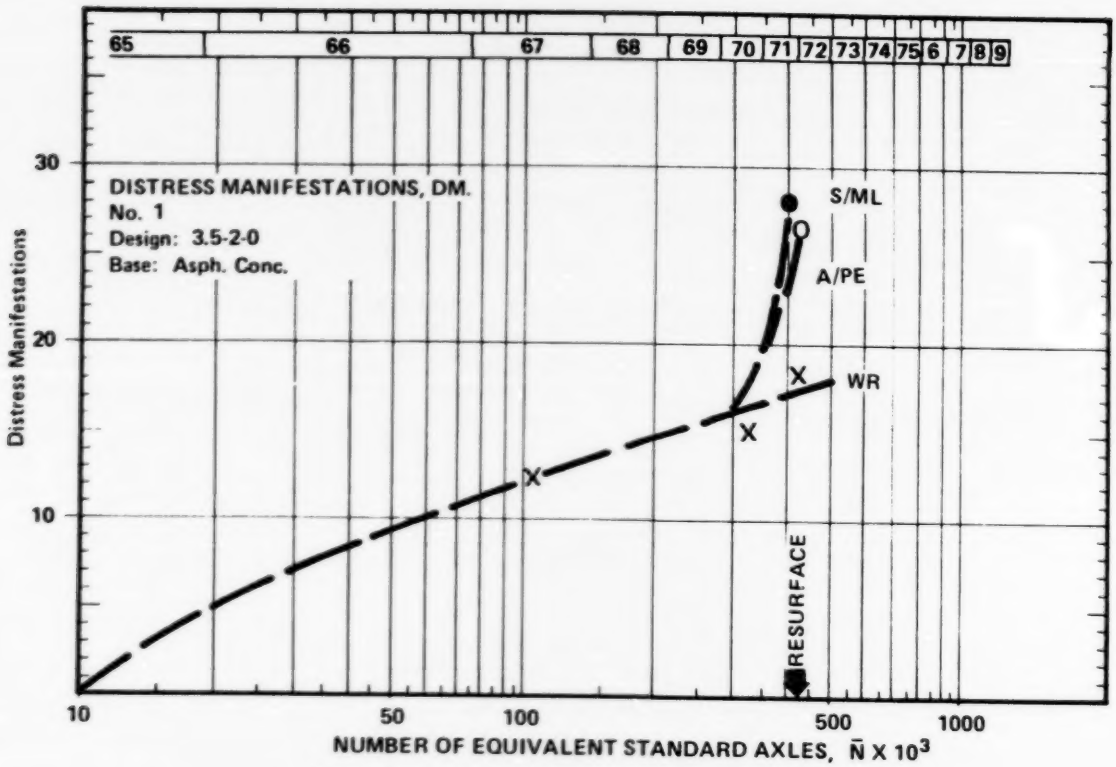


Figure 3.1 Progression of Pavement Distresses

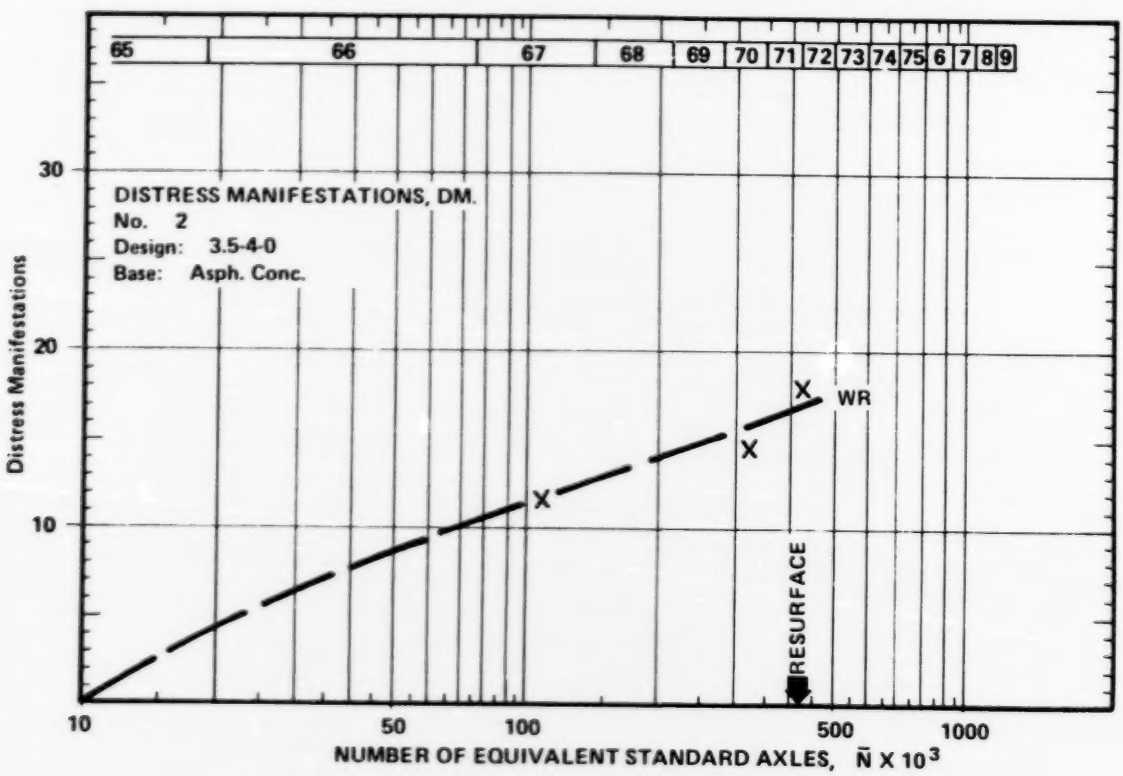


Figure 3.2 Progression of Pavement Distresses

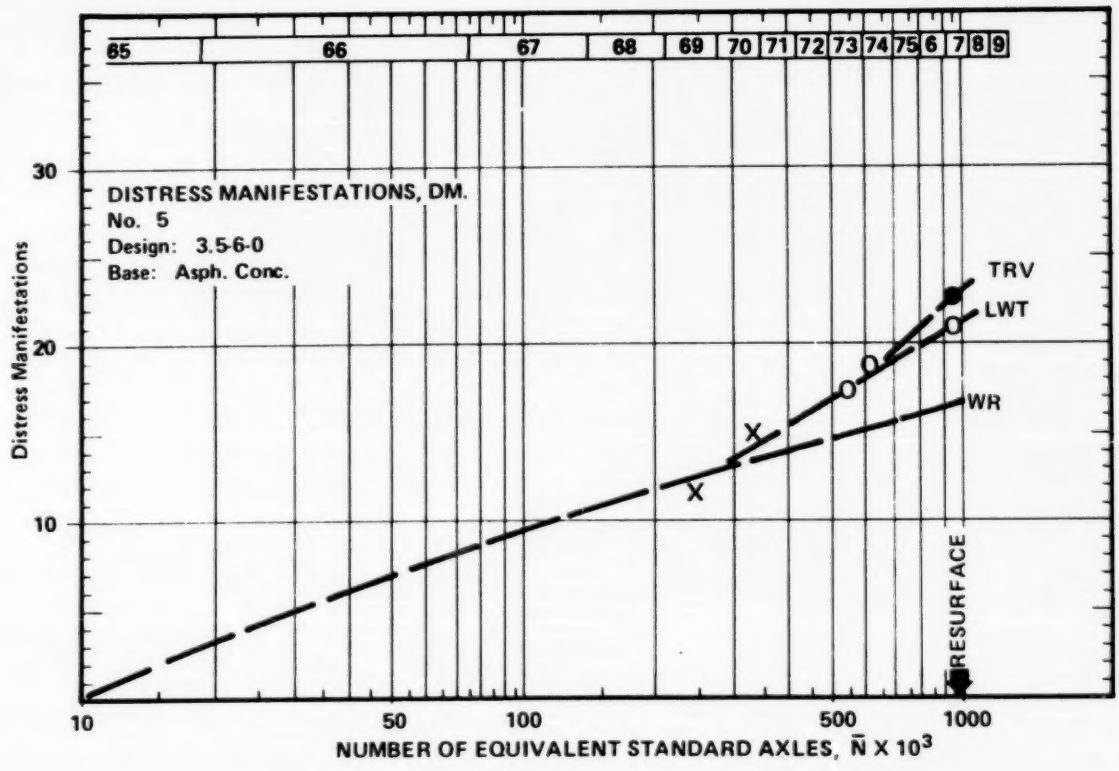


Figure 3.3 Progression of Pavement Distresses

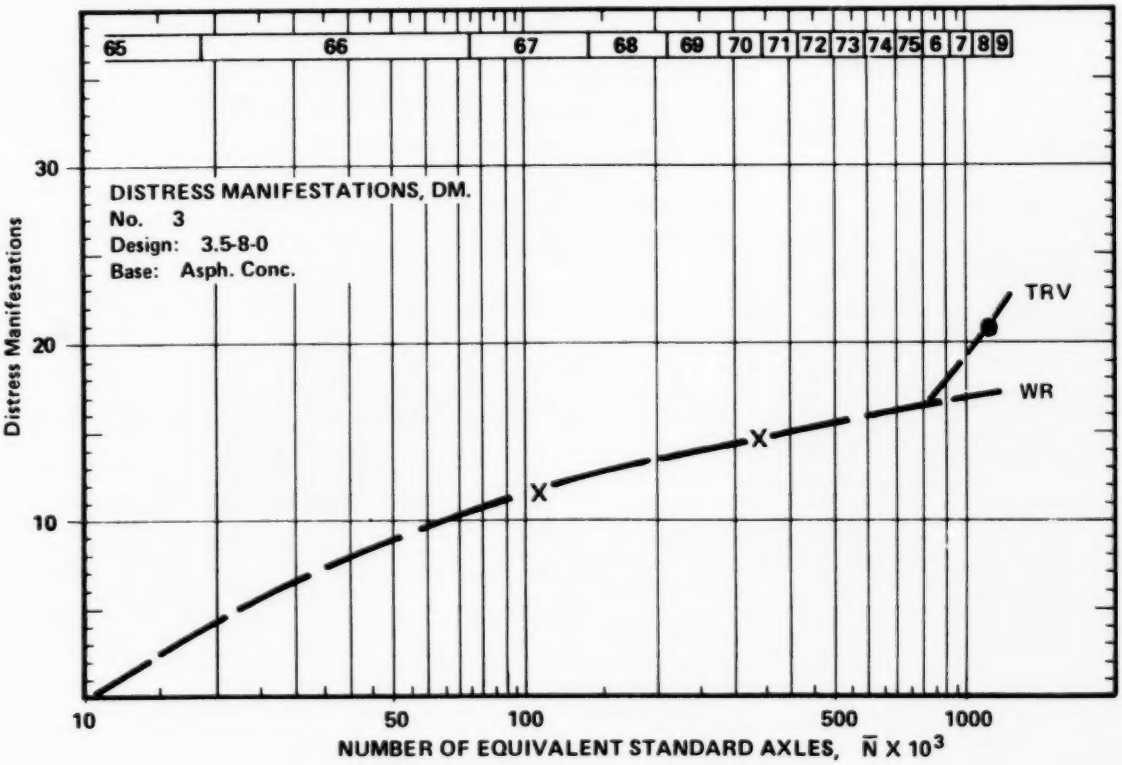


Figure 3.4 Progression of Pavement Distresses

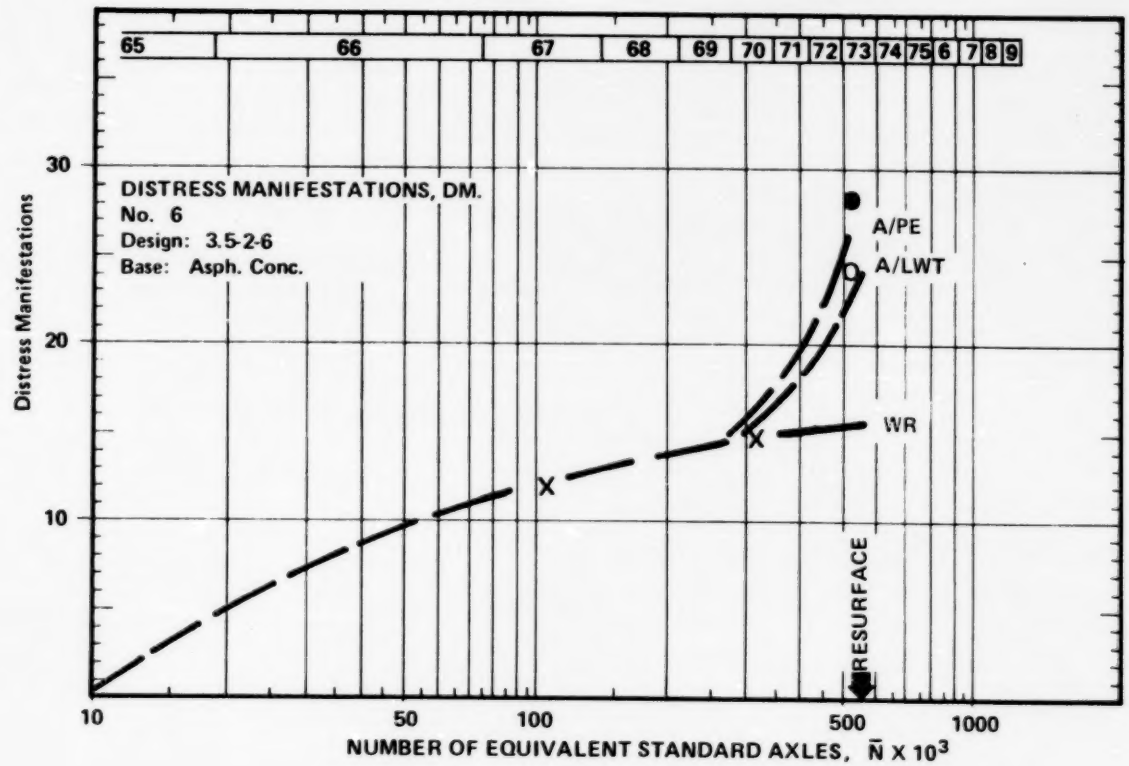


Figure 3.5 Progression of Pavement Distresses

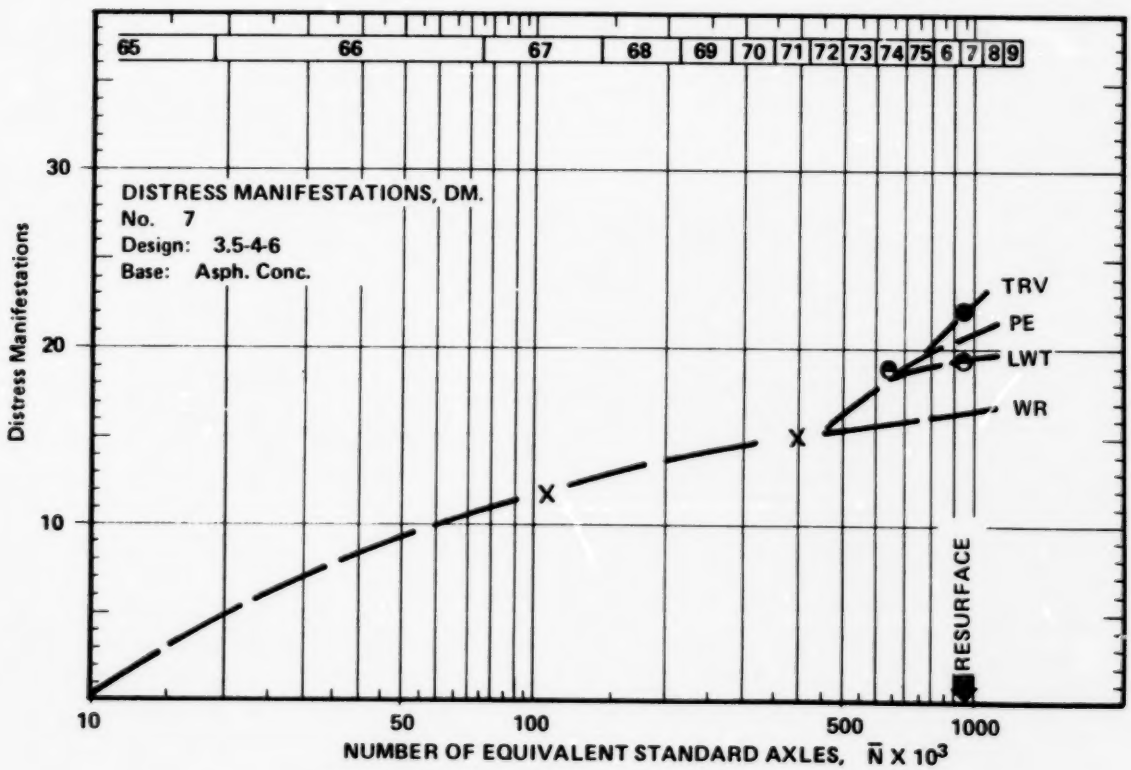


Figure 3.6 Progression of Pavement Distresses

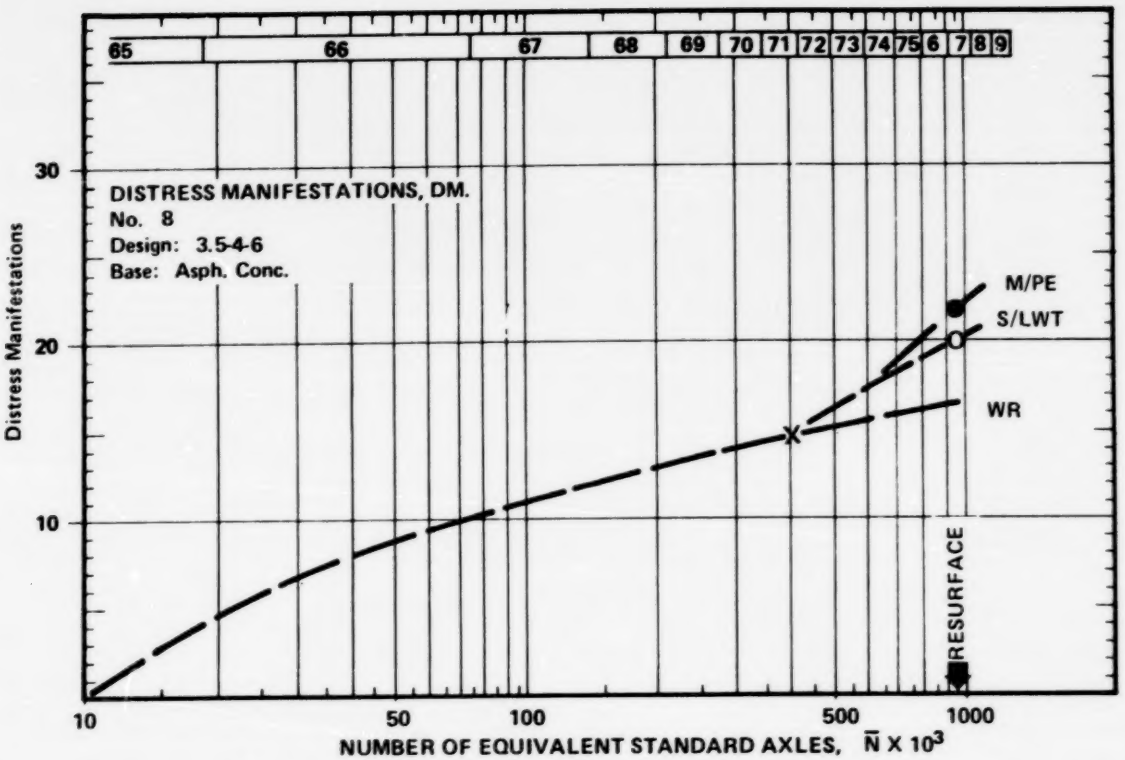


Figure 3.7 Progression of Pavement Distresses

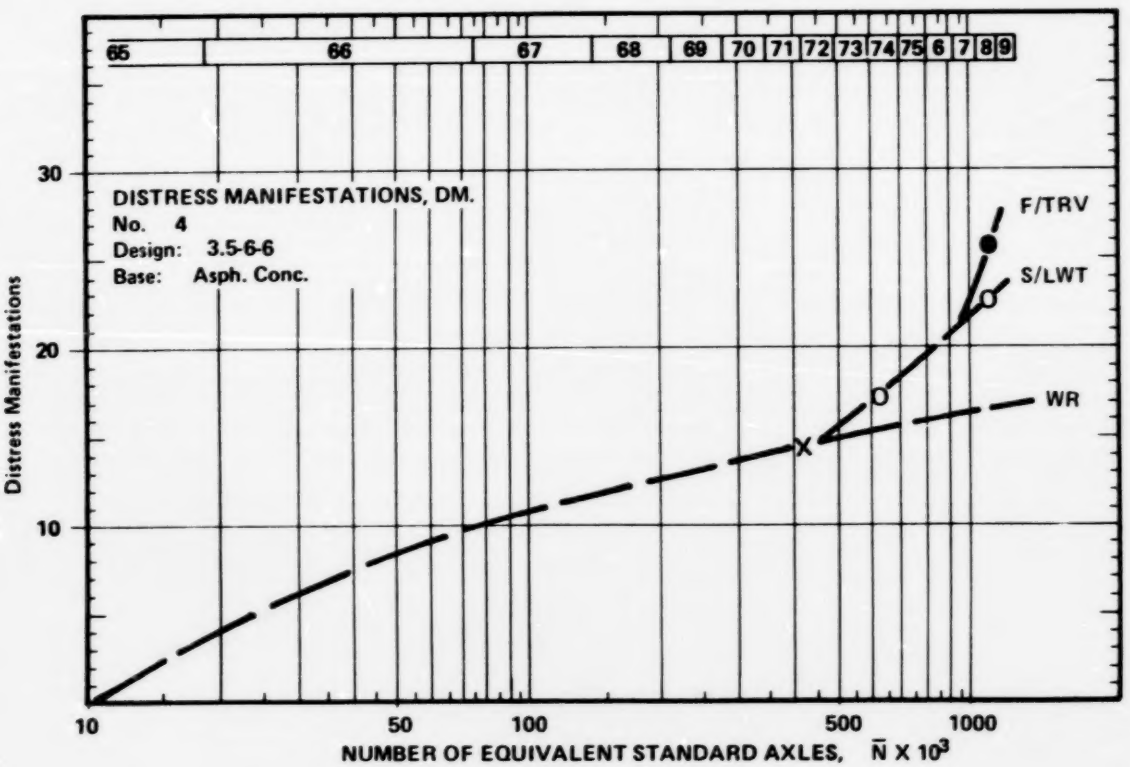


Figure 3.8 Progression of Pavement Distresses

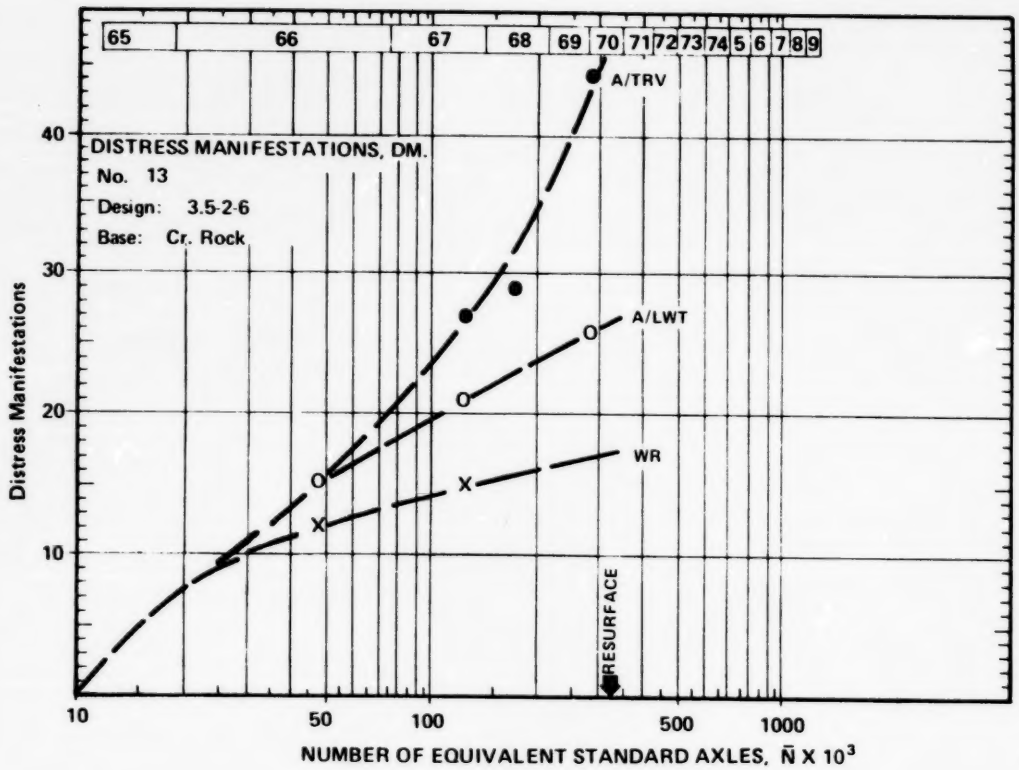


Figure 3.9 Progression of Pavement Distresses

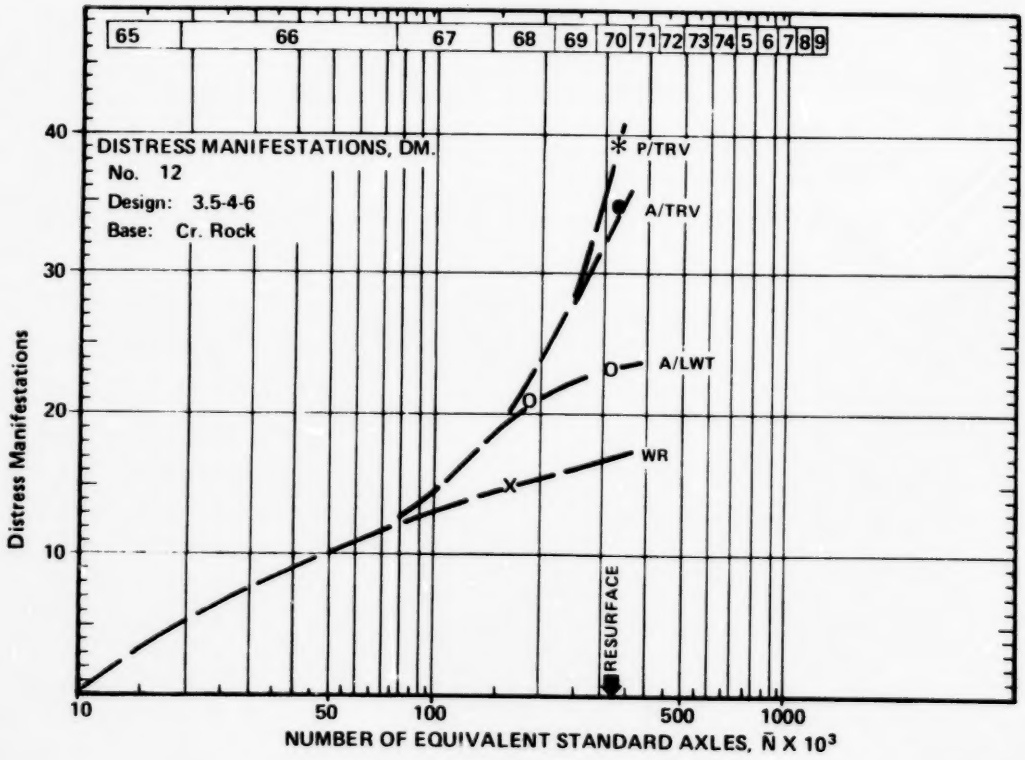


Figure 3.10 Progression of Pavement Distresses

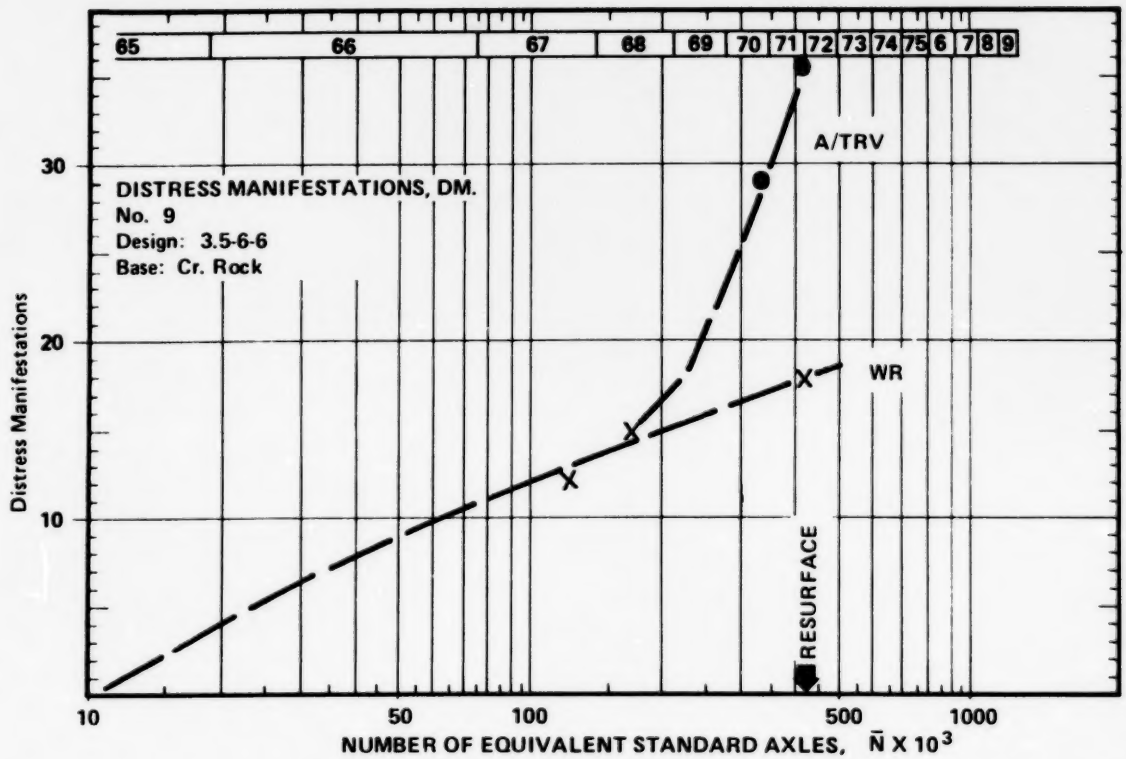


Figure 3.11 Progression of Pavement Distresses

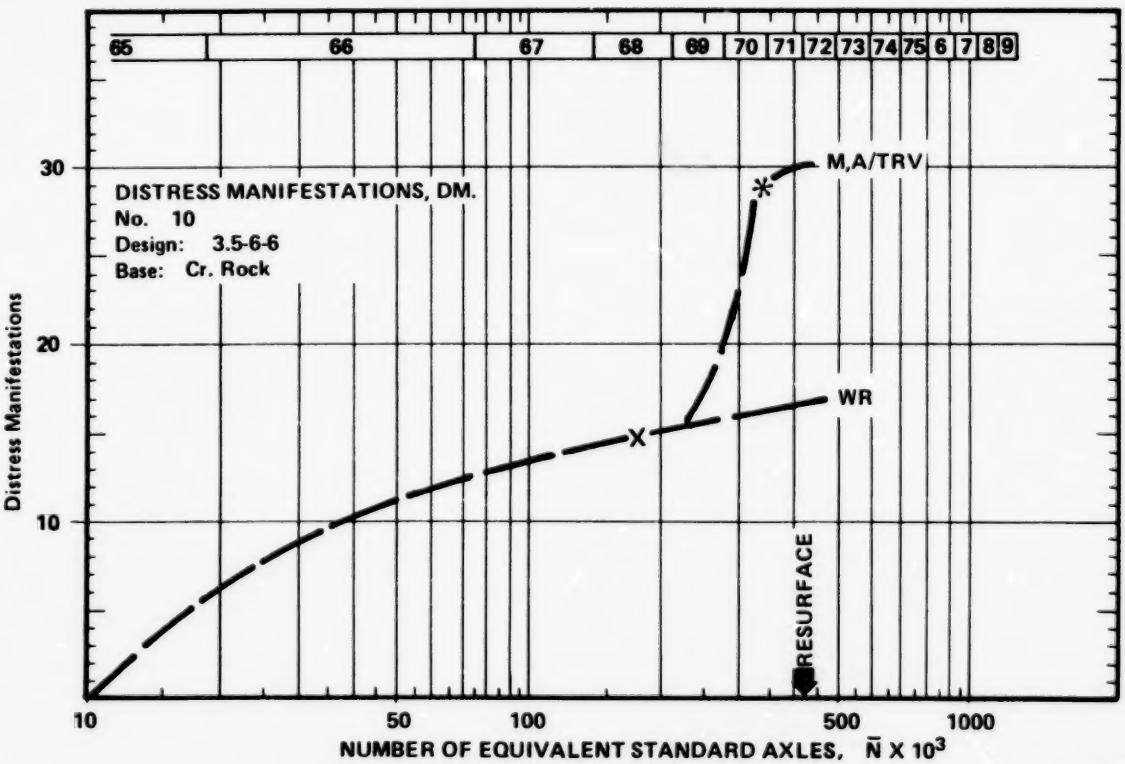


Figure 3.12 Progression of Pavement Distresses

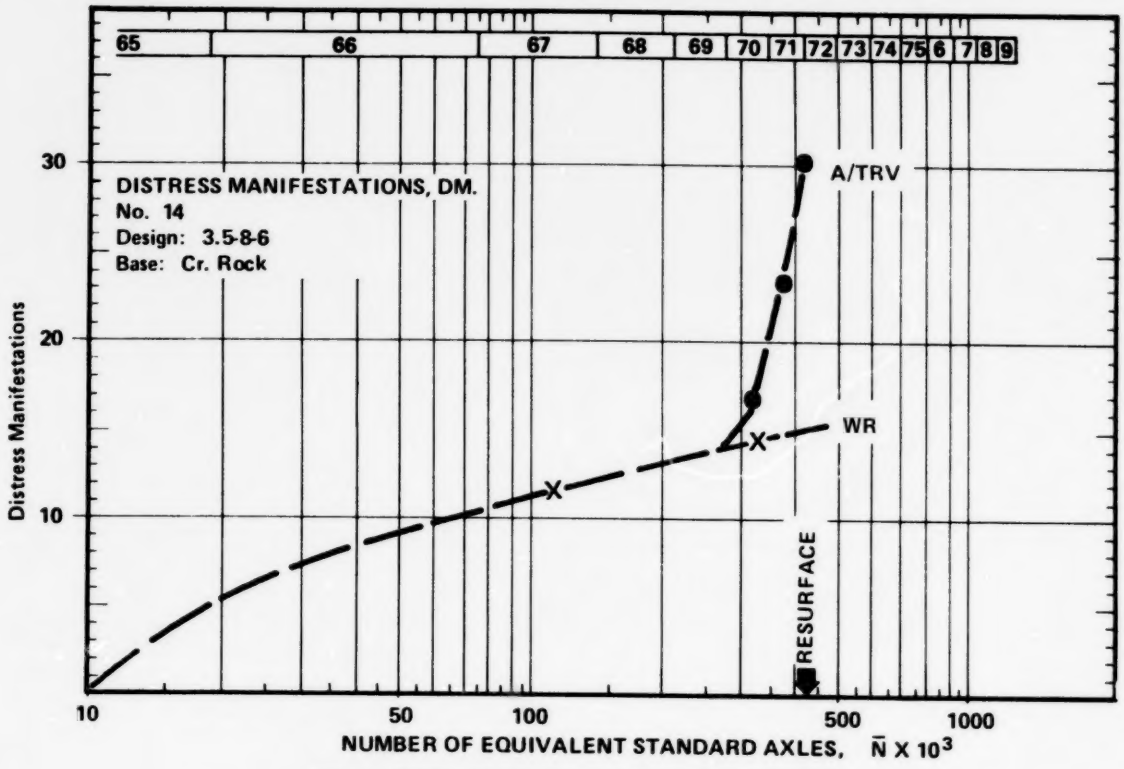


Figure 3.13 Progression of Pavement Distresses

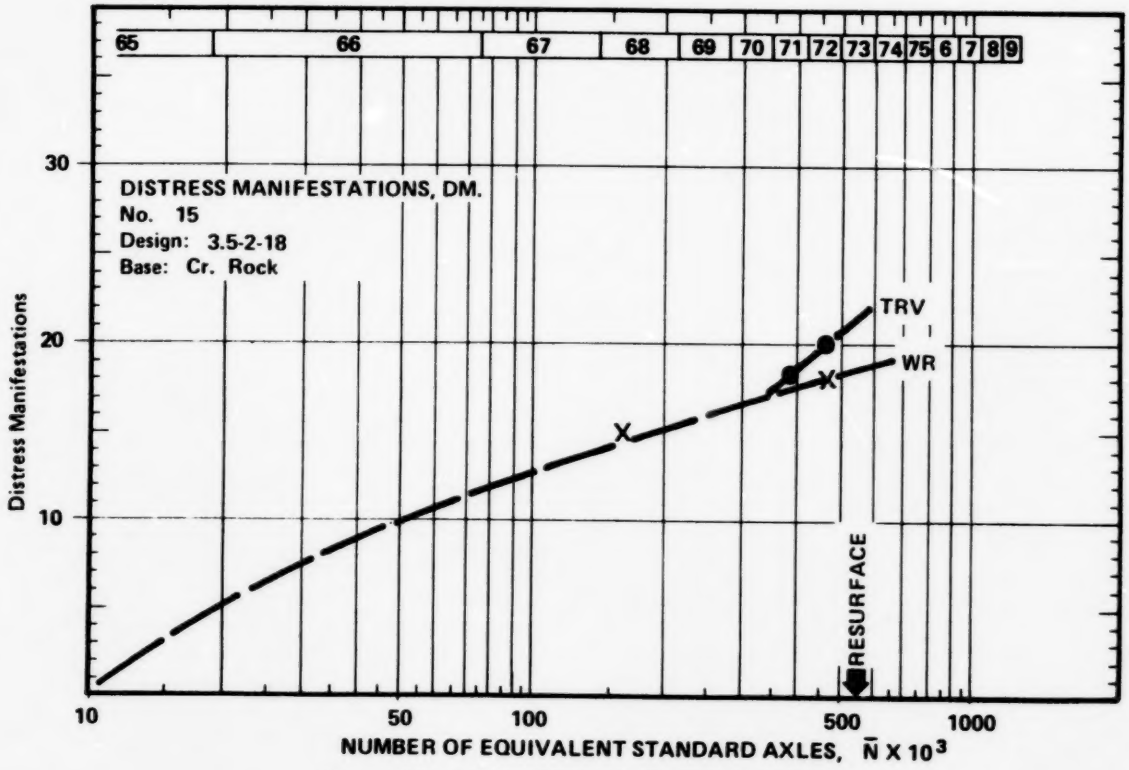


Figure 3.14 Progression of Pavement Distresses

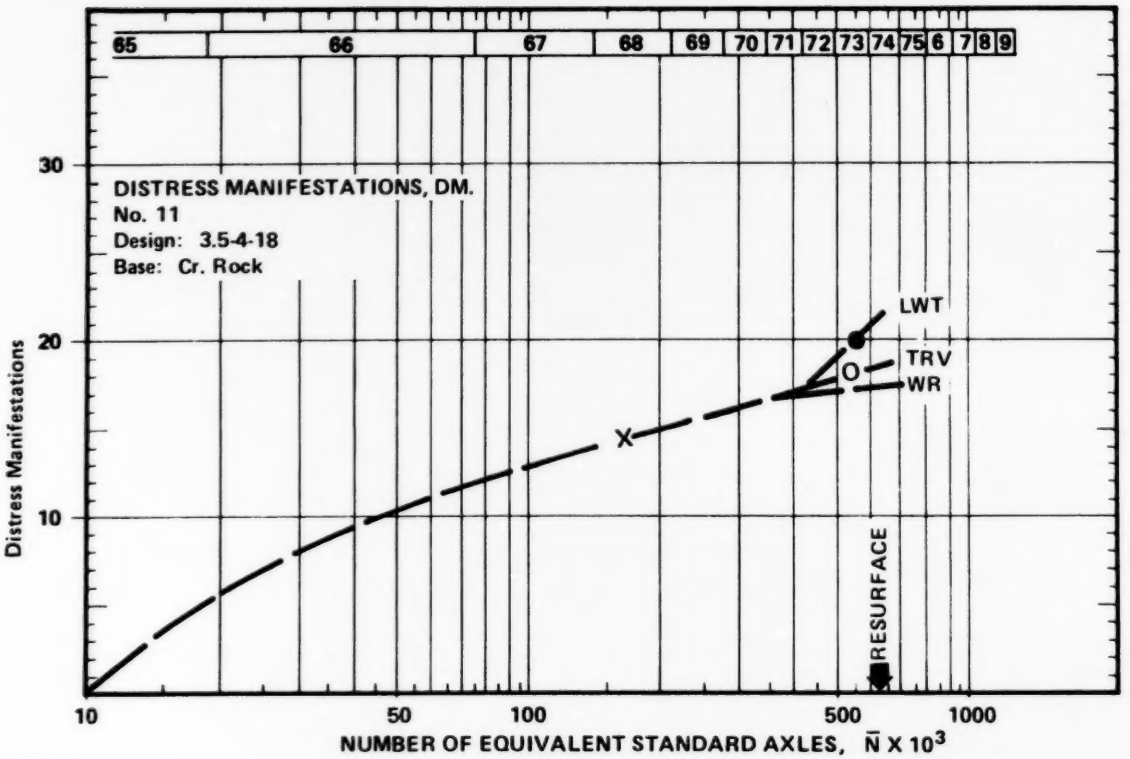


Figure 3.15 Progression of Pavement Distresses

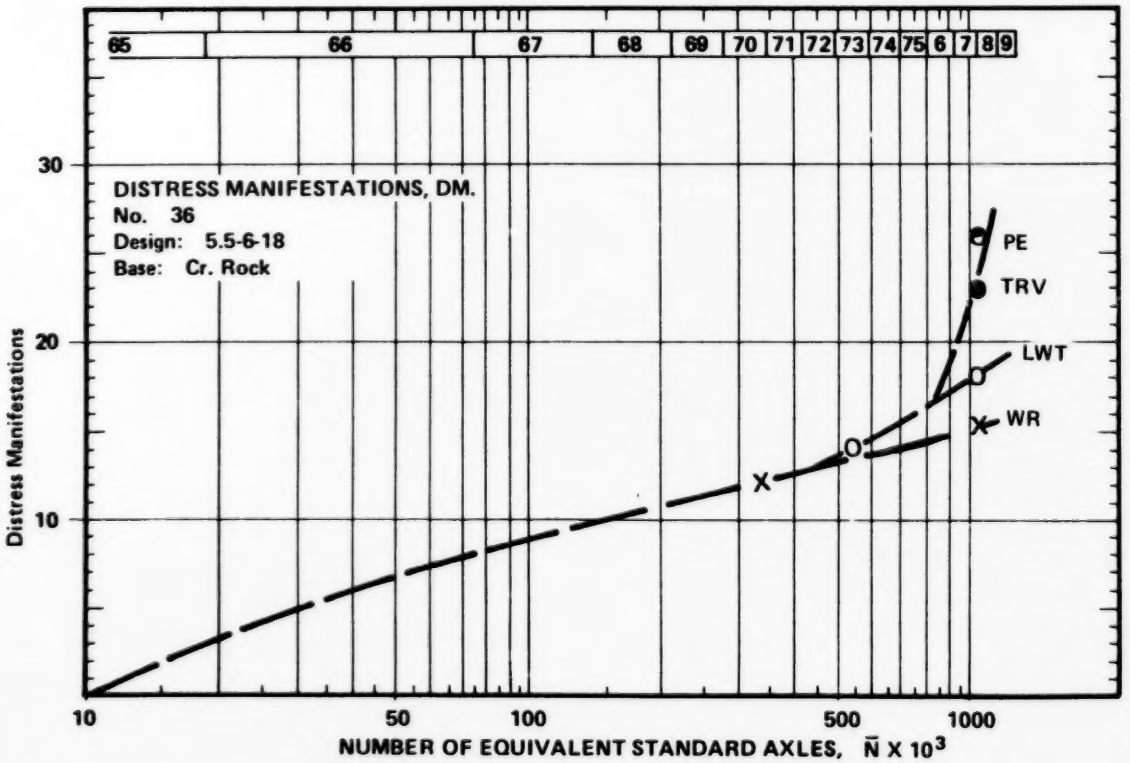


Figure 3.16 Progression of Pavement Distresses

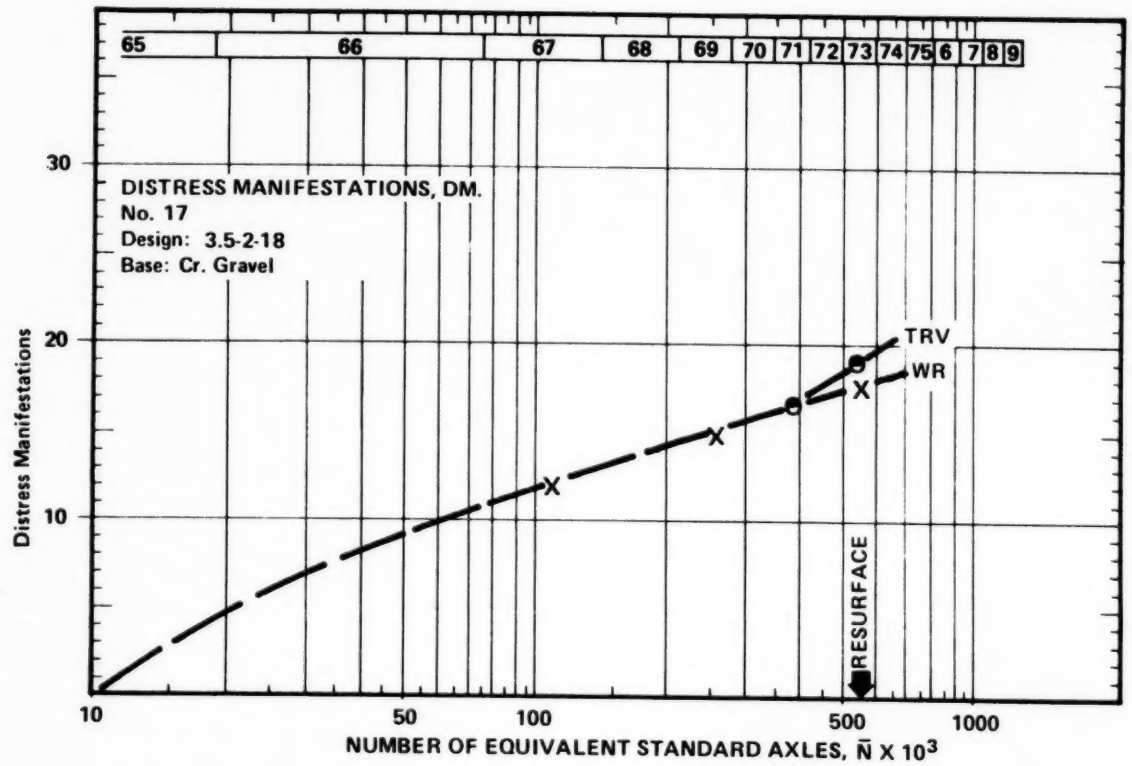


Figure 3.17 Progression of Pavement Distresses

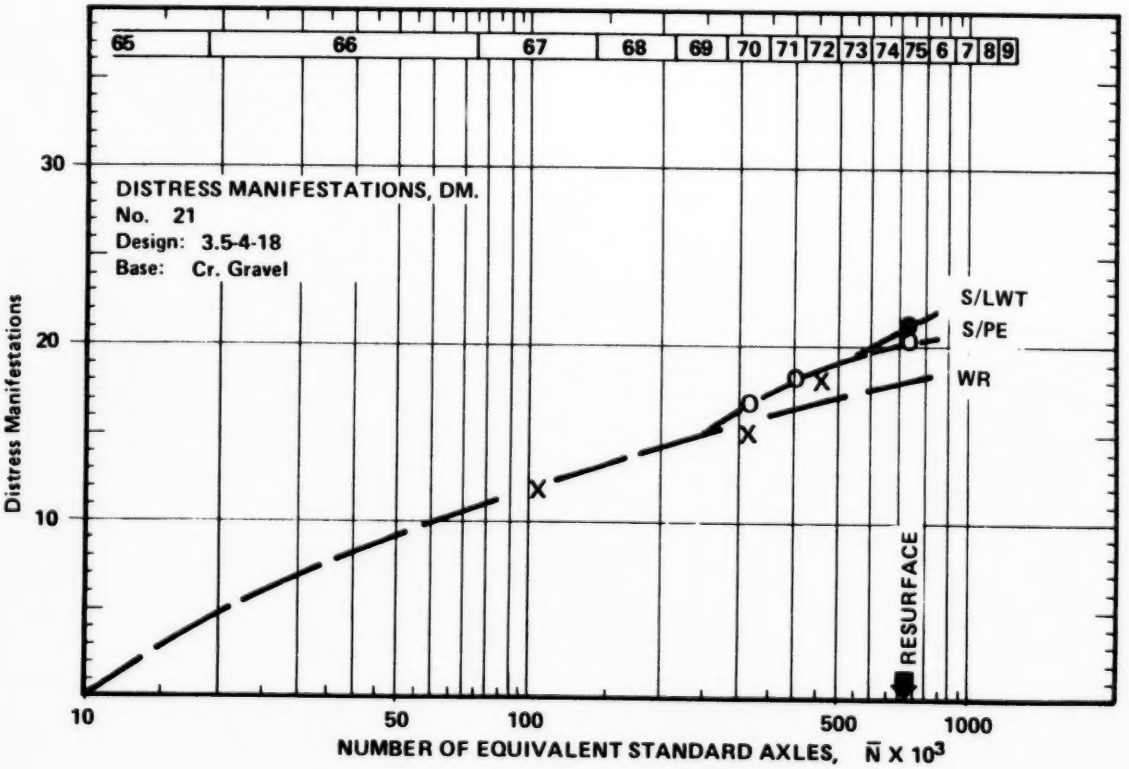


Figure 3.18 Progression of Pavement Distresses

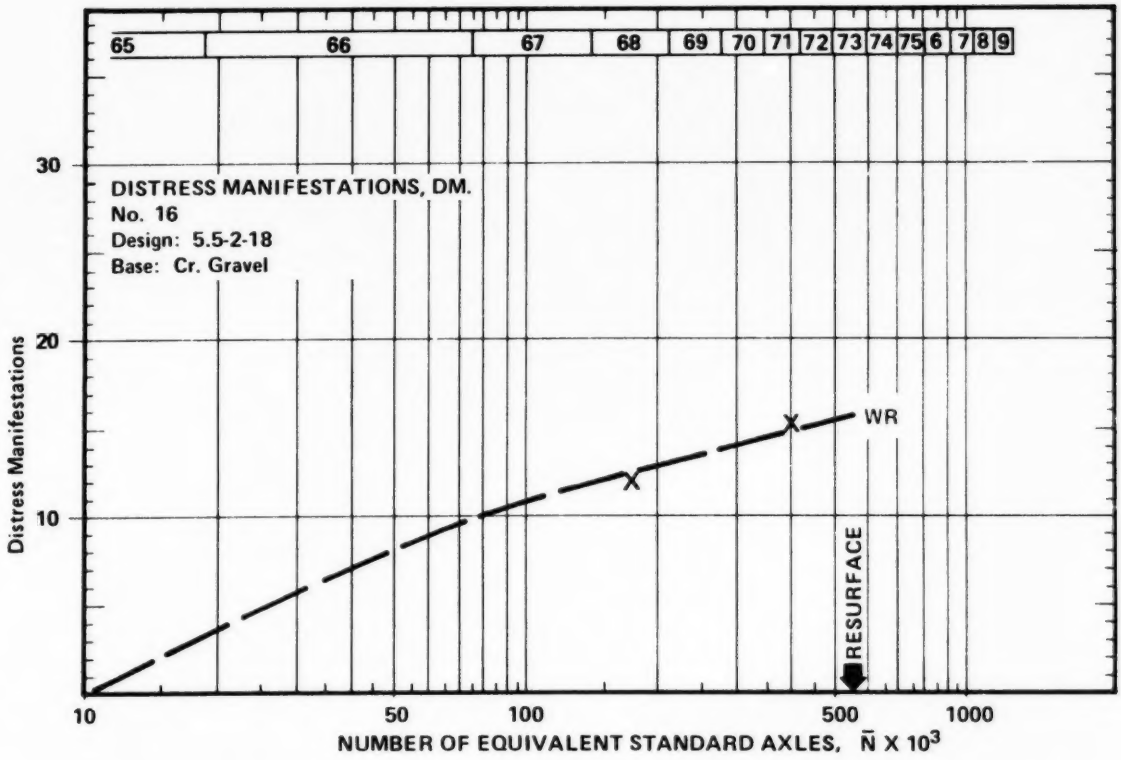


Figure 3.19 Progression of Pavement Distresses

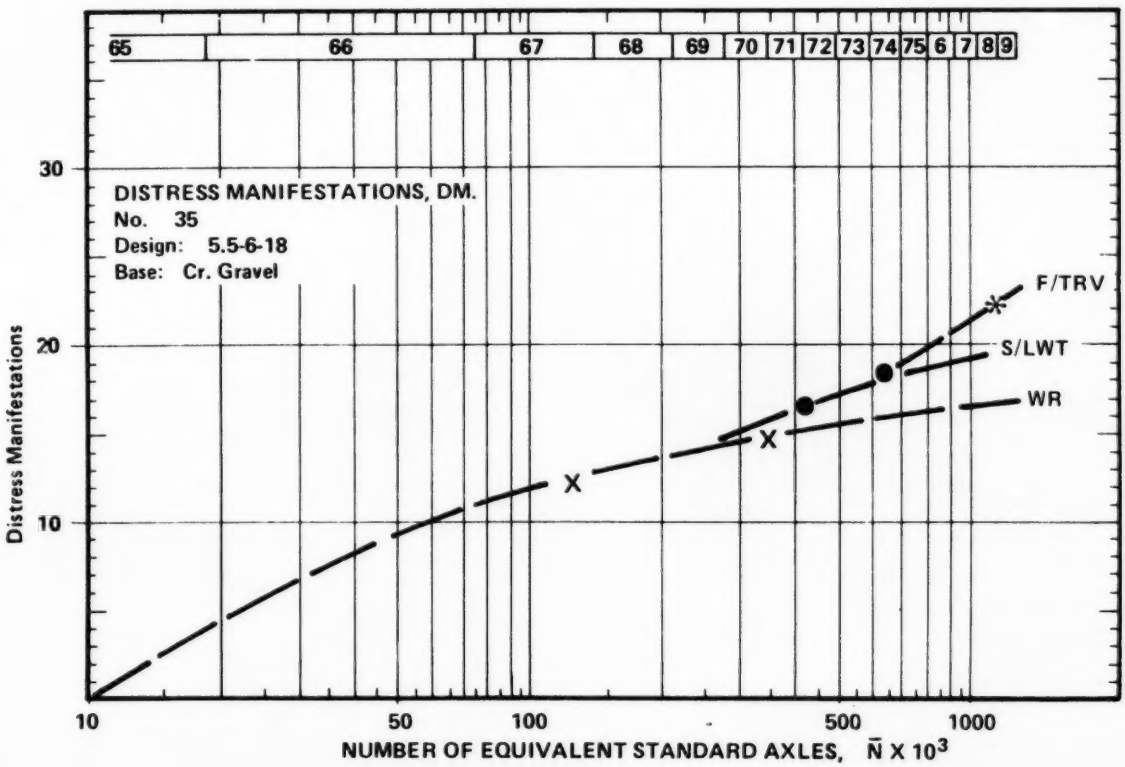


Figure 3.20 Progression of Pavement Distresses

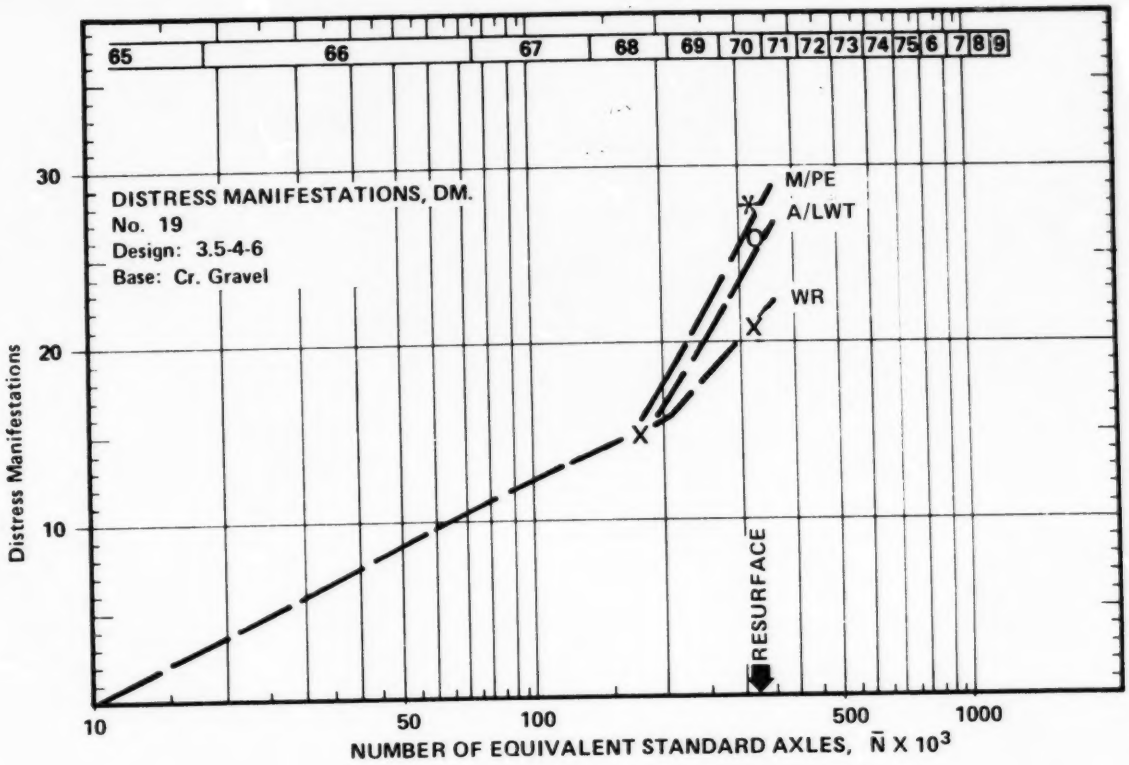


Figure 3.21 Progression of Pavement Distresses

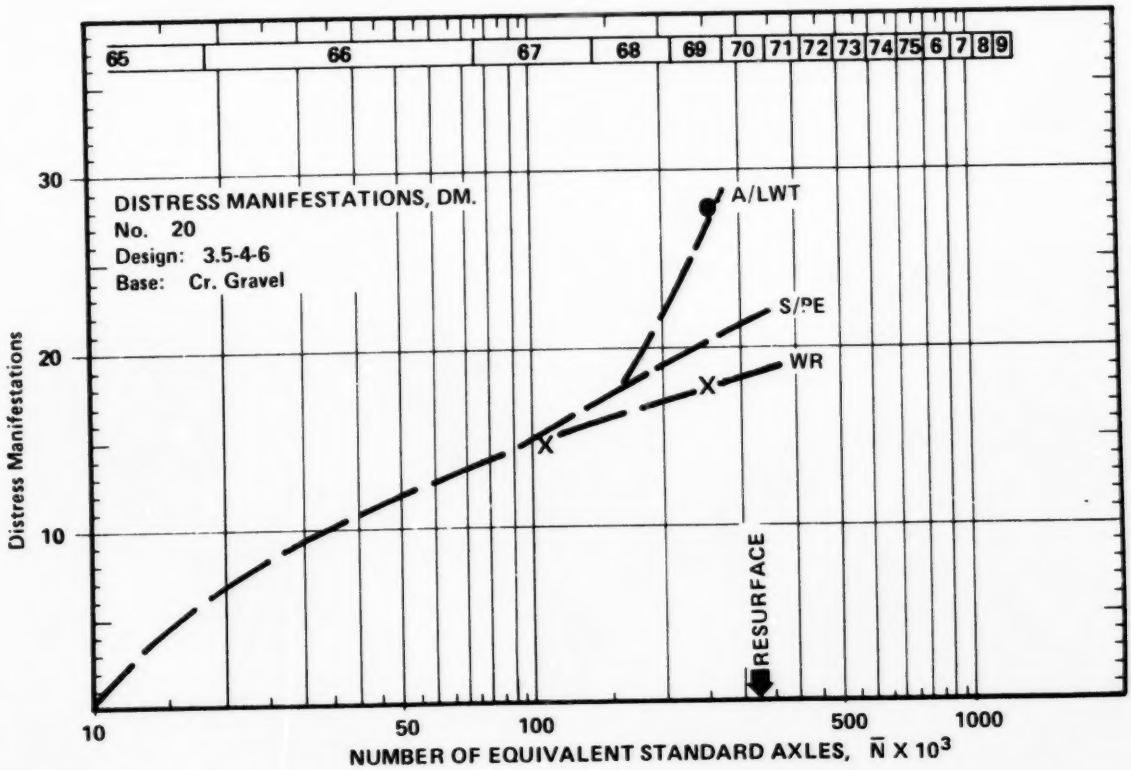


Figure 3.22 Progression of Pavement Distresses

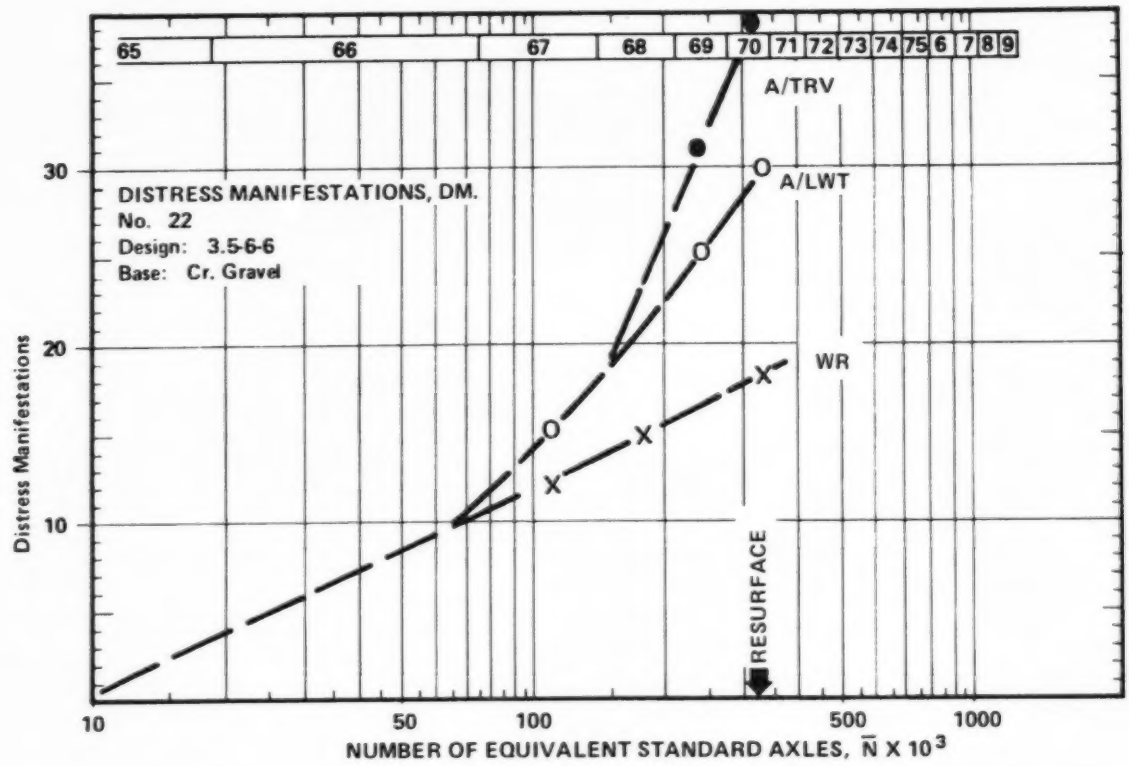


Figure 3.23 Progression of Pavement Distresses

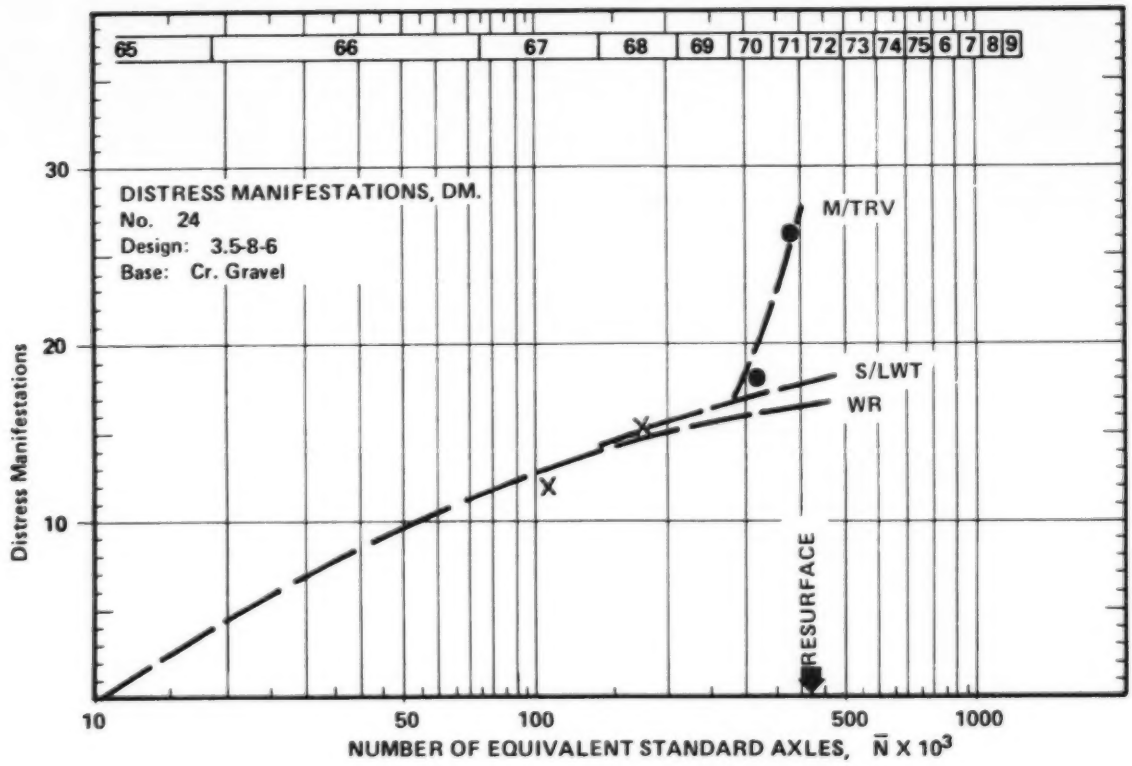


Figure 3.24 Progression of Pavement Distresses

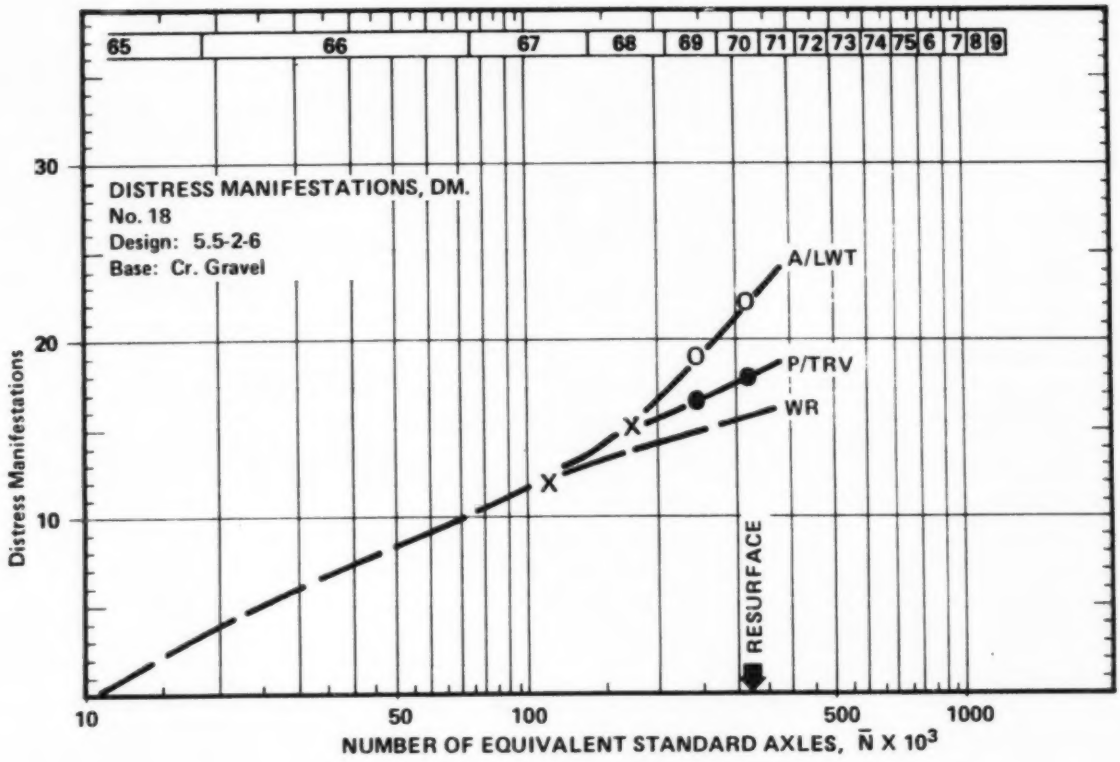


Figure 3.25 Progression of Pavement Distresses

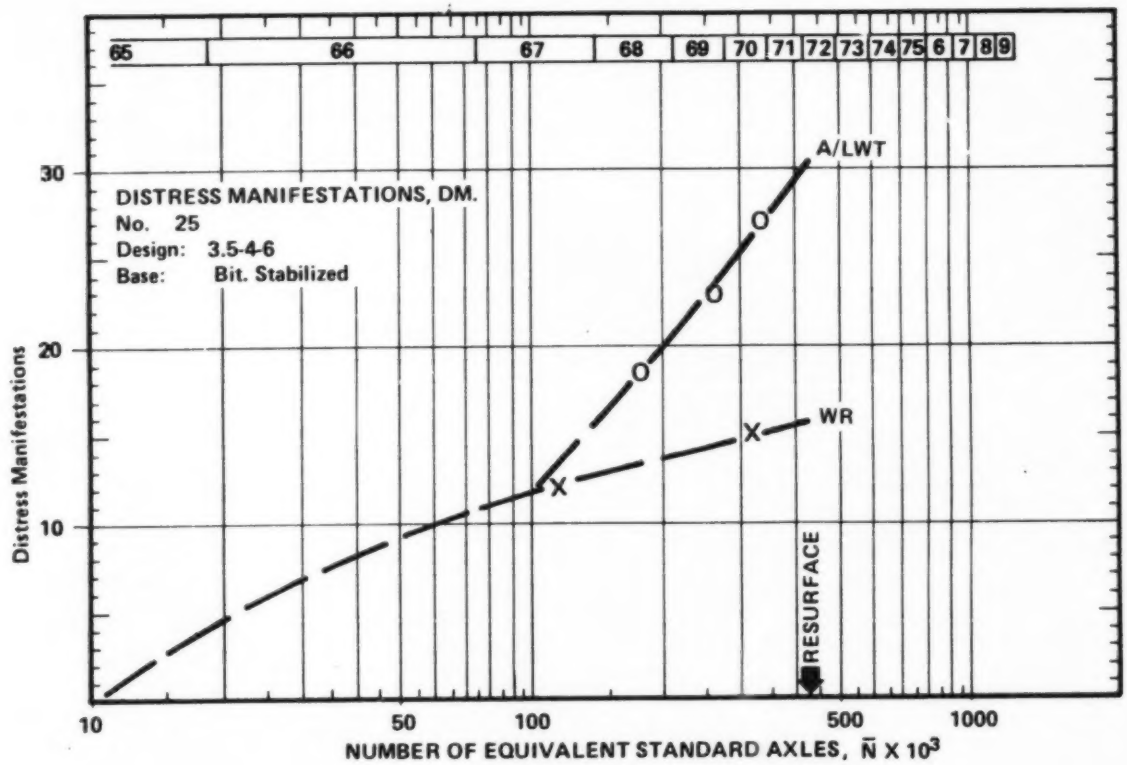


Figure 3.26 Progression of Pavement Distresses

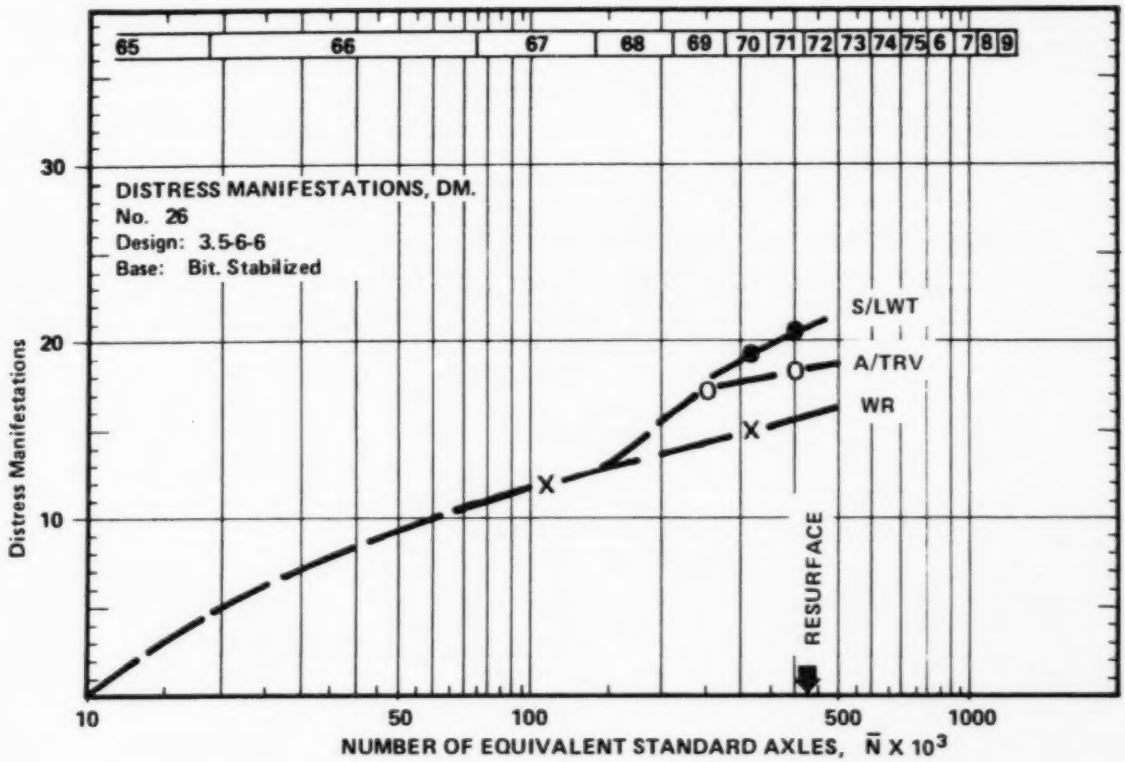


Figure 3.27 Progression of Pavement Distresses

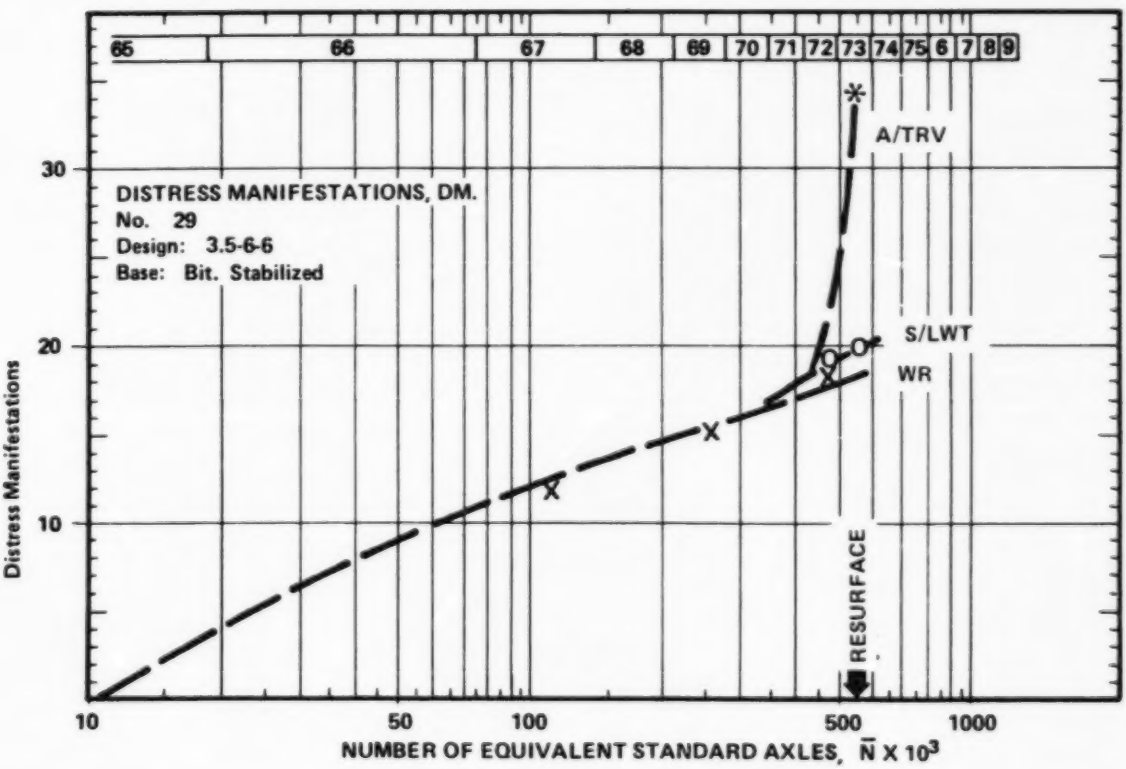


Figure 3.28 Progression of Pavement Distresses

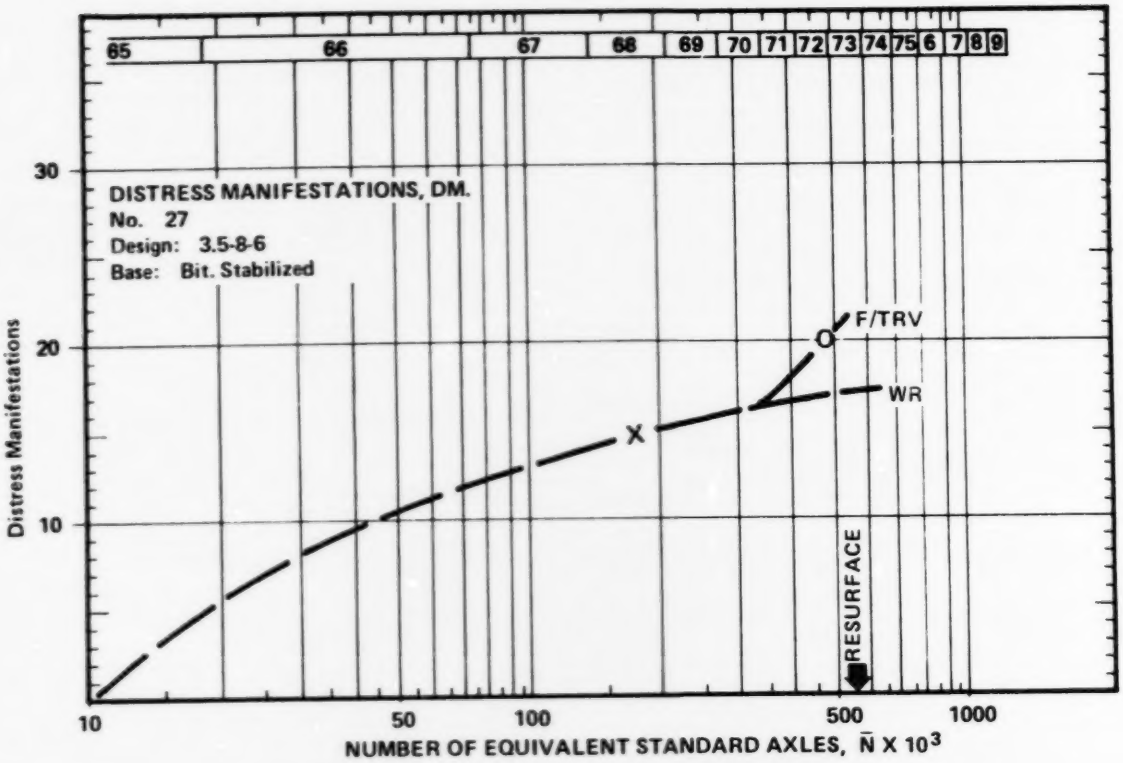


Figure 3.29 Progression of Pavement Distresses

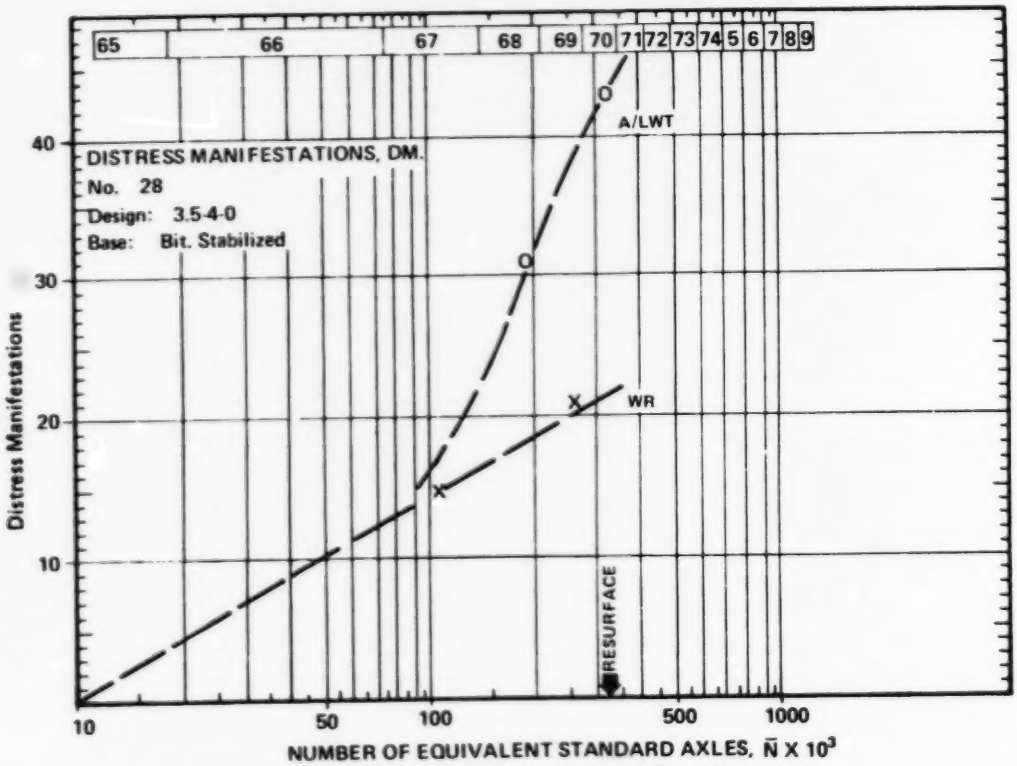


Figure 3.30 Progression of Pavement Distresses

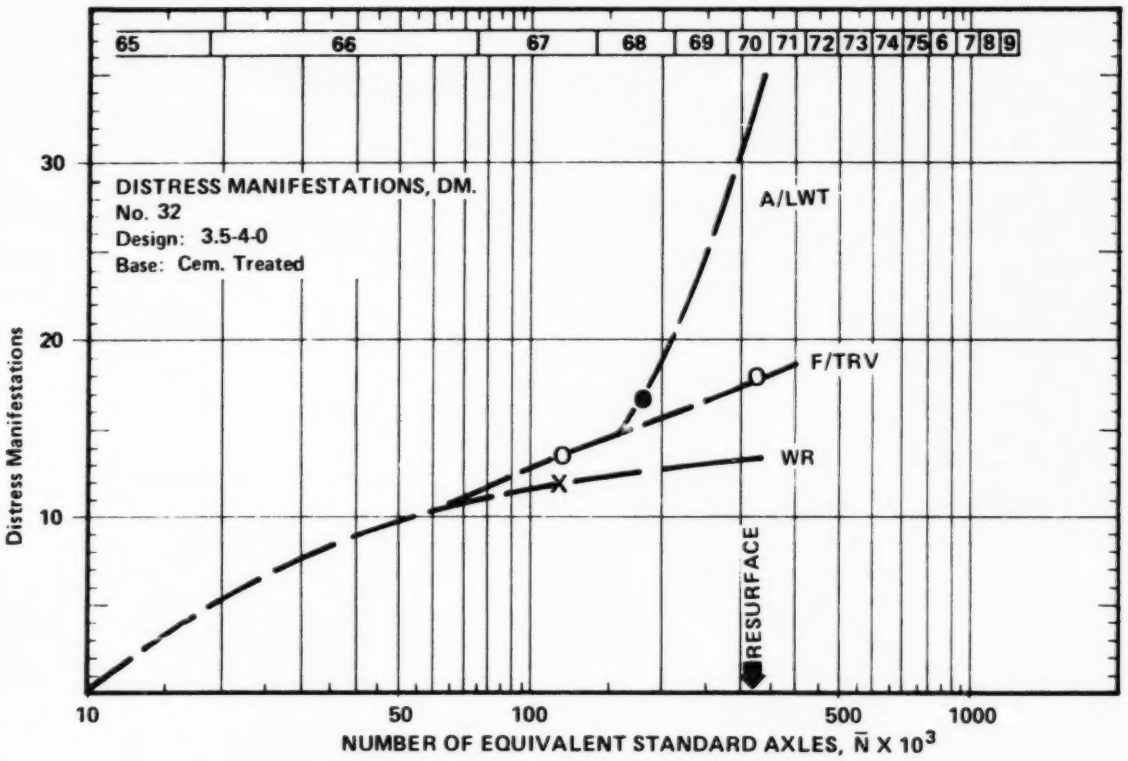


Figure 3.31 Progression of Pavement Distresses

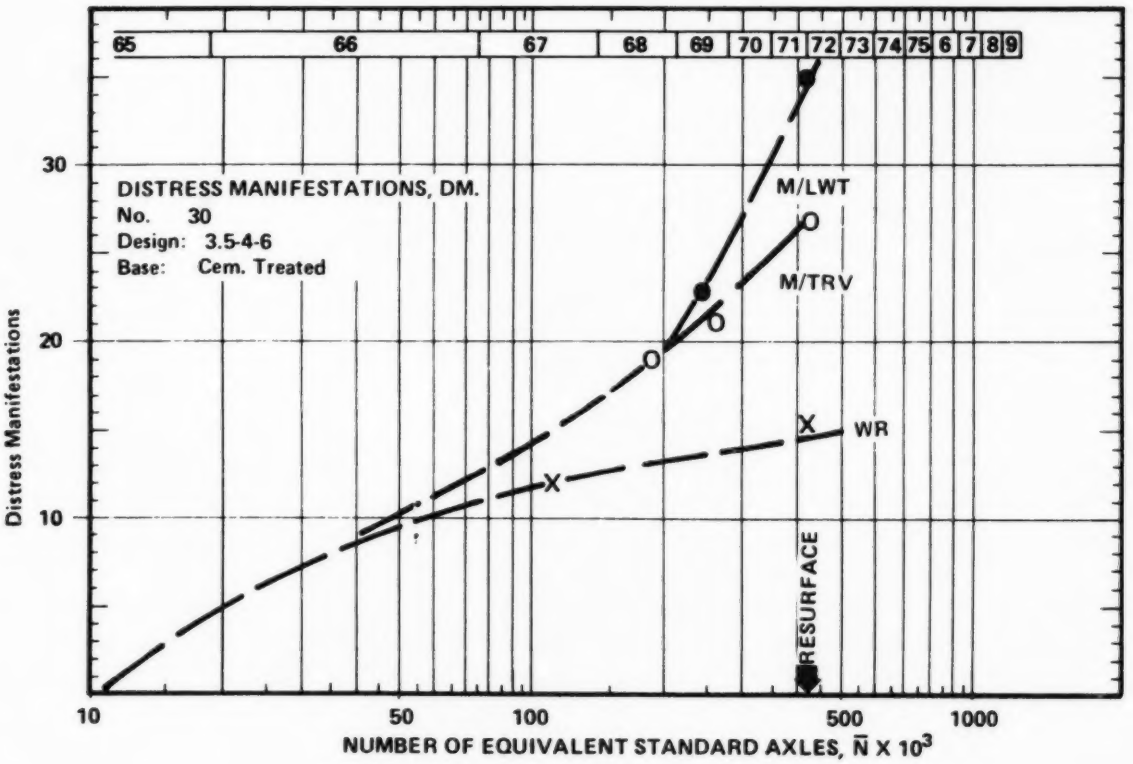


Figure 3.32 Progression of Pavement Distresses

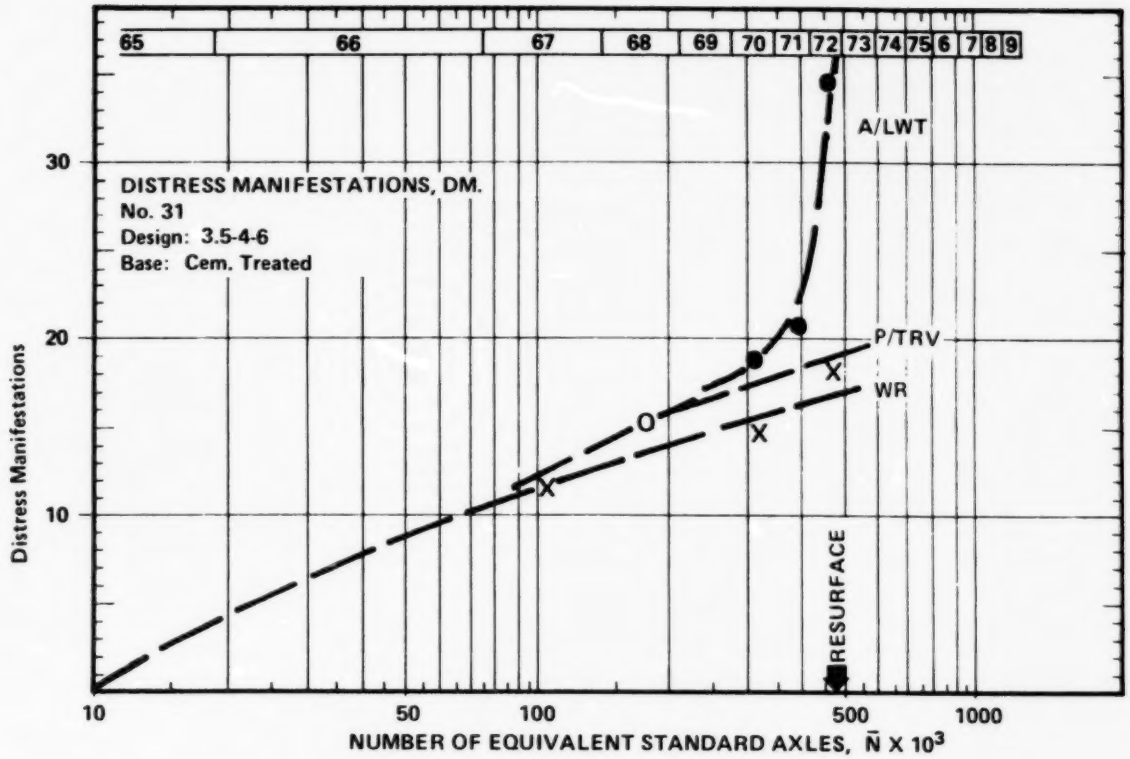


Figure 3.33 Progression of Pavement Distresses

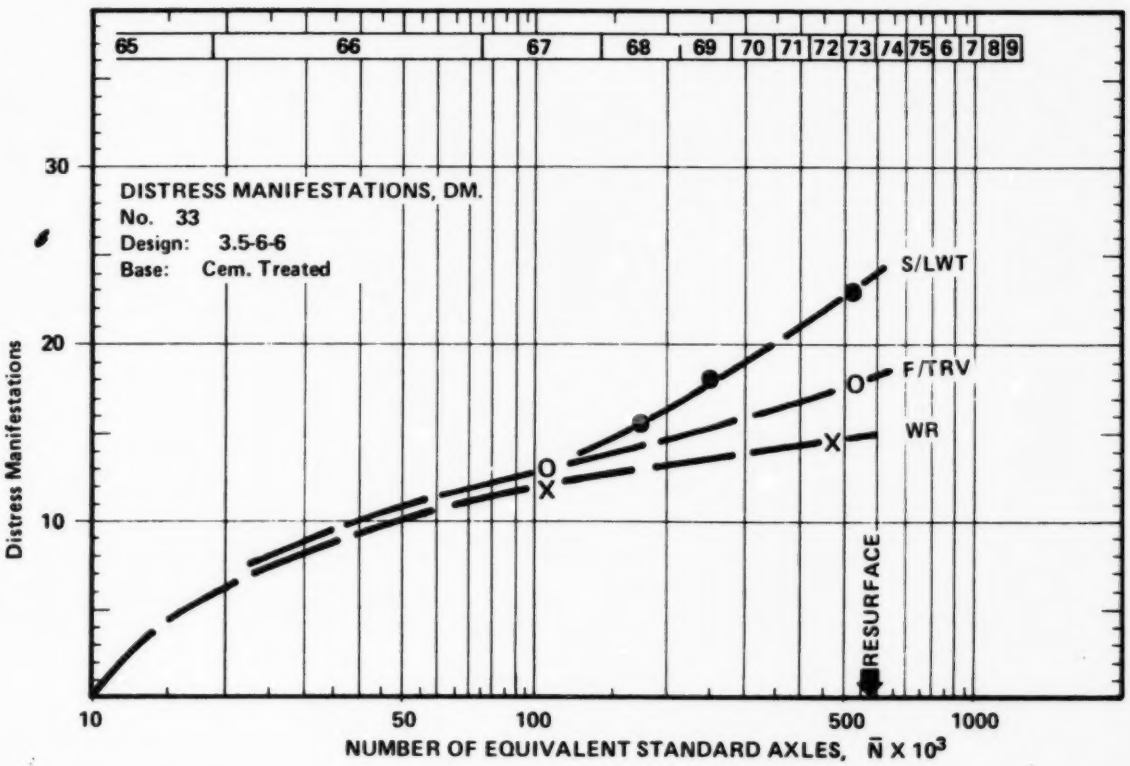


Figure 3.34 Progression of Pavement Distresses

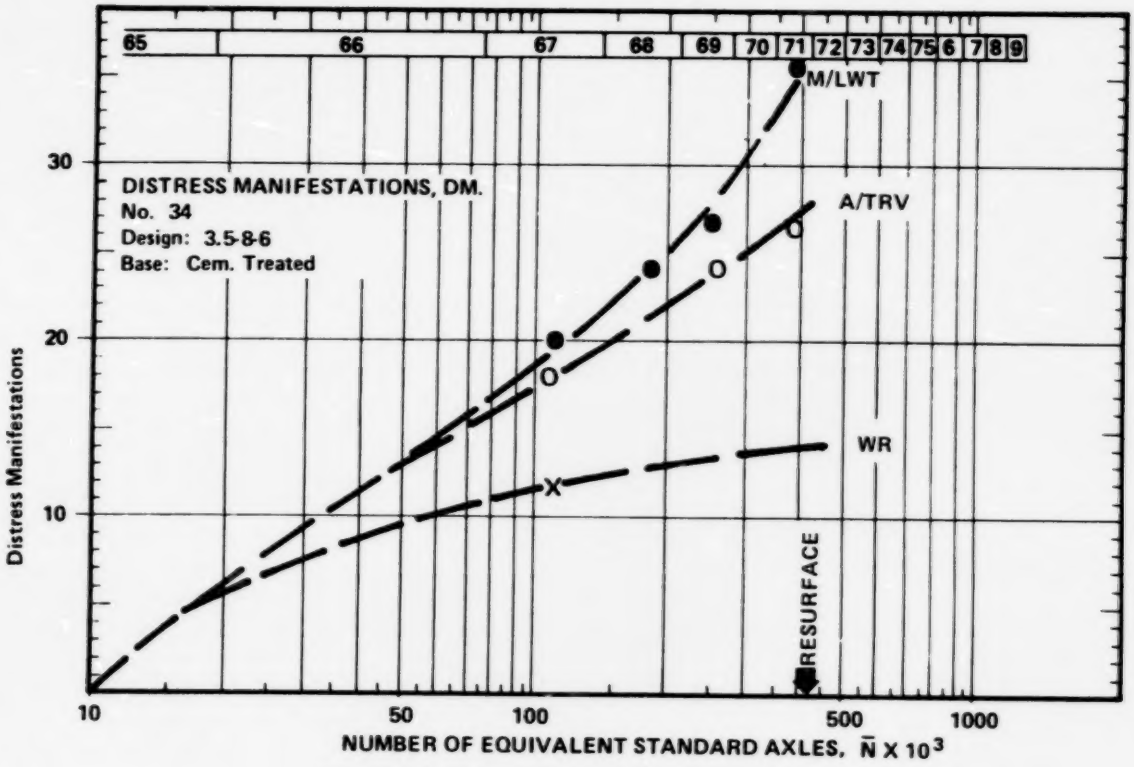
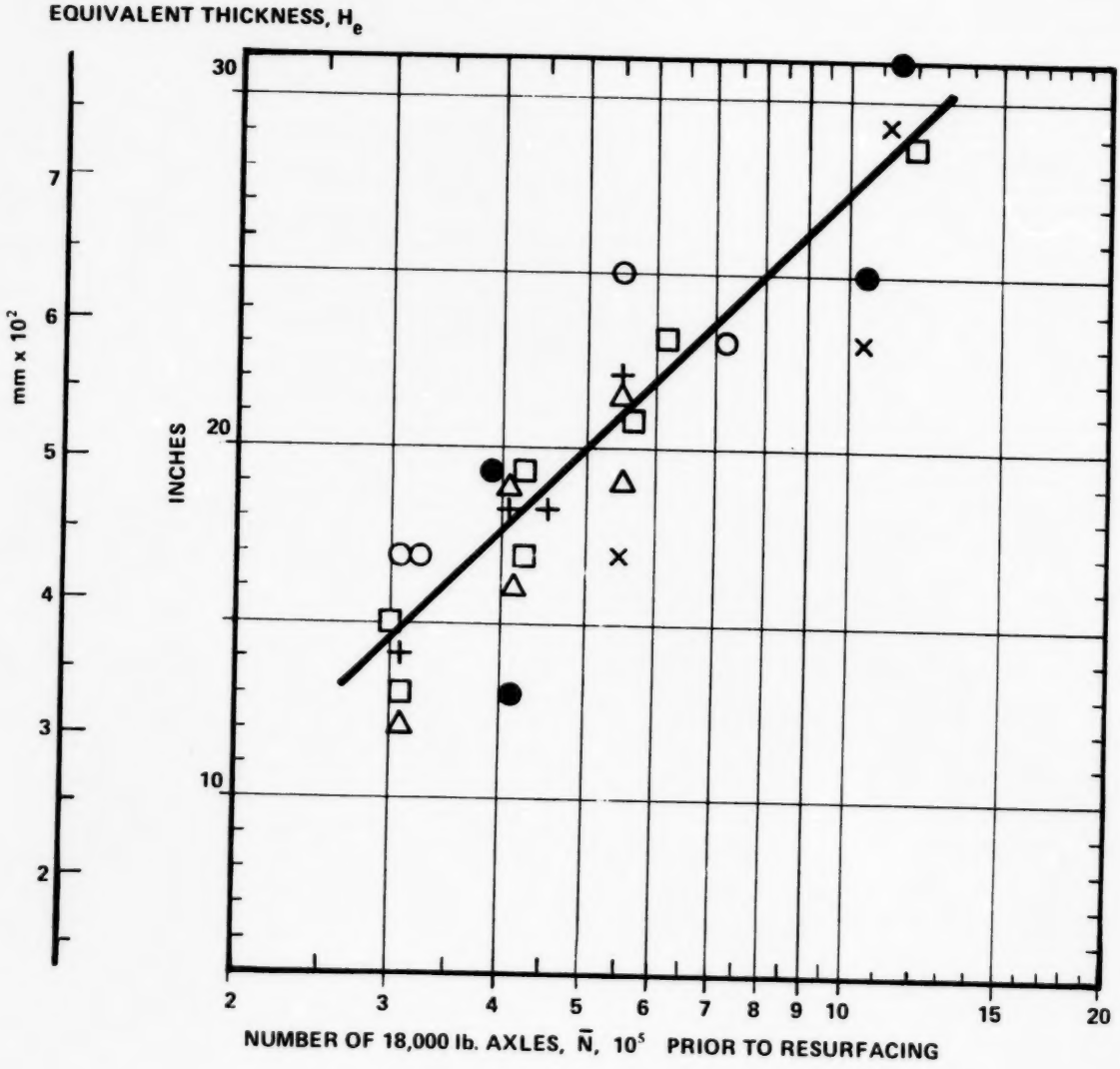


Figure 3.35 Progression of Pavement Distresses



	GRAVEL EQUIVALENT
○ CR. GRAVEL	1.0
□ CR. ROCK	1.0
△ BIT. STAB.	1.3
+ CEM. TREAT.	1.8
● ASPH. CONC. F.D.	2.0 <3.5"> 3.0
× ASPH. CONC. D.S.	2.0 <3.5"> 3.0

$H_e = -45.9 + 10.62/n \ \bar{N}$

$r^2 = 0.83$ WITHOUT D.S. ASPH. CONC.

Figure 4/ Equivalent Gravel vs. Axles to Resurfacing